November 30, 1933

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Engineering News-Record

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Engineering and Public Affairs

• **PUBLIC AFFAIRS TODAY**, as never before, bear the impress of engineering. Dominating the day's news are the PWA program, the CWA work-relief plan, federal housing and great national hydropower projects. Hardly less momentous than these is the construction-code battle, and in the background loom developments involving Mississippi River flood control, irrigation expansion and the St. Lawrence project.

• **PLAINLY, THIS IS A TIME** for engineers to give thought to public affairs. Congress soon will have to answer questions of major import to the profession. Shall the Civil Works plan be continued? Shall the PWA fund be increased to continue the momentum of re-employment progress? Shall stimulation of the capital-goods industries be assisted with renewed vigor? Decision on such questions will find a dependable guide in well-considered engineering opinion. And by his own study and reflection, each individual engineer will contribute toward shaping that opinion in the proper mould.

• **BACK OF ALL ENGINEERING THOUGHT** on these great problems stand the high ideals of the engineering profession. Among these ideals, soundness of planning, thoroughness of construction, efficiency in the use of labor and of the nation's resources of power and materials have always occupied prominent places. They must continue to do so if the greatest service to the community is to be rendered, and if the impress of engineering on public affairs is to mark healthful progress.

ARTICLES IN THIS ISSUE: Building a Railroad Viaduct Through a Building . . . Concrete Buildings for Beer Storage . . . Designing and Operating a Small Sewage Plant . . . Roughness Coefficients in Open Channels . . . Earthquake Shock Transmission in Tall Buildings

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Engineering News-Record

New York

November 30, 1933

Railroad Viaduct Carried Through Occupied Building

Foundations adjacent to building footings on piles consist of steel cylinders jacked to rock under air and filled with concrete — Viaduct carefully insulated from building occupied by Bell Telephone Laboratories in New York

By George T. Gilman
Moran & Proctor, Consulting Engineers, New York City

THE elevated structure which the New York Central Railroad Co. is building along the Hudson River side of the Borough of Manhattan, New York City, has involved many interesting and difficult engineering problems. None is more unique than that occasioned by the necessity for carrying the viaduct through an existing building occupied by the Bell Telephone Laboratories, Inc., the research organization of the American Telephone & Telegraph Co. The foundation problem was particularly difficult, and its solution was attended by unusual procedure. Briefly, the work required that eight concrete caissons, located between existing building columns, be jacked 60 to 80 ft. to a bearing on rock. Noise and vibration being objectionable to the occupants of the building, special design and construction precautions had to be taken.

The viaduct, a single-deck double-track structure, is to carry New York Central freight tracks between the huge new St. Johns Park terminal building, a few blocks south of the Bell Laboratories and the yards at 30th St. When the viaduct is put into service, the present tracks will be removed from the street surface. The cost of the work is borne jointly by the New York Central Railroad, the state of New York and New York City.

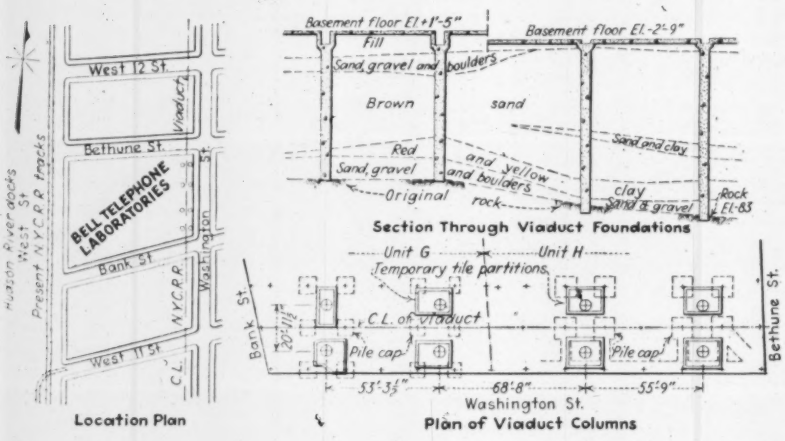
At the Bell Telephone Laboratories, the railroad structure occupies the greater part of the second, third and fourth stories of units G and H, which form the Washington St. front of the building group. Unit G, built in 1900, is a three-story steel-frame building supported on wood piles, which records indicate, have a minimum length of 6 ft. Unit H, built in 1926, is an eleven-story steel-frame structure supported on concrete piles. The piles under both buildings were driven into a sand formation underlying the site, but it is likely that the short piles under Unit G

Fig. 1—Railroad viaduct piercing New York building is founded on steel cylinders sunk 60 to 80 ft. to rock and filled with concrete. The viaduct is carefully insulated from the building and its pile-supported footings.

landed on a stratum of boulders at about El. —15, while those under Unit H did not reach a hard bearing stratum, being primarily friction piles.

The importance and refinement of the scientific research that is continuously in progress in the buildings made it imperative that construction operations be conducted with a minimum of disturbance to the occupants, and that a minimum of noise and vibration be transmitted to the building structures. With these limitations in mind, the railroad company arranged for an easement of the space through the building required for the viaduct structure in the second, third and fourth stories, together with limited areas in the basement and first story necessary for the construction of viaduct columns and their foundations. Construction operations were limited strictly to the areas stipulated in the easement, and for the foundation work it was required that the contractor work from the second-story level, installing the foundations within tile-walled inclosures in the basement and first story. All materials and equipment for the construction of the foundations entered the second story of the building and were lowered to the basement, while excavation and materials removed from the foundation work were hoisted to the second-story level and lowered to the sidewalk on the Washington St. front.

Fig. 2—Location and layout plans, showing proximity of building columns and depth to rock.



To prevent, so far as possible, the transmission of vibration from the foundations of the viaduct to the buildings, it was decided that the viaduct supports should go to rock, rather than rest on the sand formation which was already carrying the concrete and timber piles supporting the buildings, and that the methods for constructing the new piers must preclude any possibility of settling the buildings through disturbance of their pile foundations.

In addition to founding the viaduct structure on independent foundations to rock, the viaduct itself was insulated from its foundations by means of lead and asbestos vibration pads (Fig. 3). A further consideration in the determination of the type of viaduct foundations was the requirement that the viaduct itself should suffer no settlement or disturbance from any future building construction on the site.

Soil borings indicated that the formation underlying the site was generally of sand, with occasional boulders, extending to bedrock at about El.—72 to —80 below mean high water. Groundwater was found at about El.—2 or 9 in. above the basement floor of Unit H, and therefore, pumping was required continuously from the start to the finish of the job. For a considerable period all the pits were pumped simultaneously to lower the groundwater level.

The design of the viaduct called for eight supporting piers within the building limits, located as shown in Fig. 2. The proximity of the existing piles to these new piers, necessitated a method of foundation installation that would eliminate loss of ground or other disturbance under the old footings. Accordingly, the foundation design contemplated jacking 4½-ft.-diameter cylinders to rock, using the weight of the buildings plus some additional load in Unit G as the jacking reaction. It was originally planned that each cylinder be jacked to a considerable depth and excavated in the open, carrying a substantial plug in the lower end to prevent inflow of material; when this operation should become hazardous, an air lock would be installed to complete the pier by pneumatic methods. The first cylinder was excavated in the open for a short distance below water level, after which it was completed under air, and the remaining cylinders were constructed almost completely by the pneumatic process, as open excavation below water level presented hazards which it seemed unnecessary and undesirable to risk.

The general arrangement for jacking the cylinders is shown in Fig. 4. The cylinders, made of ½-in. steel plate, were delivered to the job in 5-ft. lengths. A pit was excavated to El. —7.33, the sides of the excavation being supported by timber sheeting. In this pit was placed the lower cylindrical section or working chamber, which was 9 ft. high, made of 1-in. plate and provided with a door at the top. On top of the working chamber a standard cylinder was connected, and above this a heavy circular steel jacking head was placed, which received the direct thrust of four 150-ton hydraulic jacks. The jacks in turn reacted against beams connected to a steel tower frame, the top of which was supported by girders connected to the steel columns of the buildings. The entire cylinder assembly was then jacked into the ground until sufficient clearance was obtained for the addition of another 5-ft. shell together with the air lock, which was heavily constructed to take the direct thrust of the jacks.

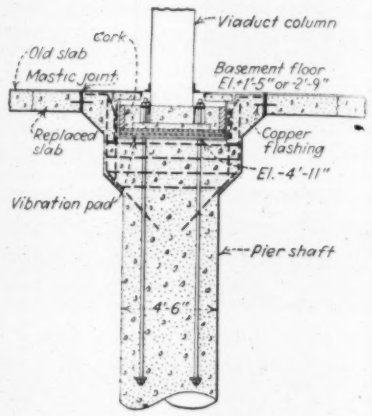


Fig. 3—The steel columns of the viaduct were insulated from the foundations by means of lead and asbestos pads.

It was estimated that a jacking force of 500 tons might be required to overcome skin friction and air pressure when sinking the caissons to the maximum depth, and jacking equipment was designed to take this load at normal stresses, with an allowance of 20 per cent increase in stress if the jacking forces were increased to 600 tons or to the full capacity of the four jacks. It was anticipated that considerable resistance to jacking would be offered at the cutting edges, which were kept well buried in the soil to prevent loss of ground. Actually about 500 tons was the maximum pressure exerted at the top of any cylinder, and this occurred while bringing the cutting edge to uniform bearing on the rock. The maximum resistance encountered while jacking the caisson through the material above ledge rock was 383 tons, exclusive of the uplift due to air pressure.

The jacks had 7-in.-diameter rams with a 24-in. stroke, and were provided with a ratchet and pawl for returning the rams. The jacks were used inverted so that their bases could be clamped to the under side of the jacking frame above. As the cylinders were jacked downward, the blocking, consisting of 12-in. extra-heavy steel pipe, was

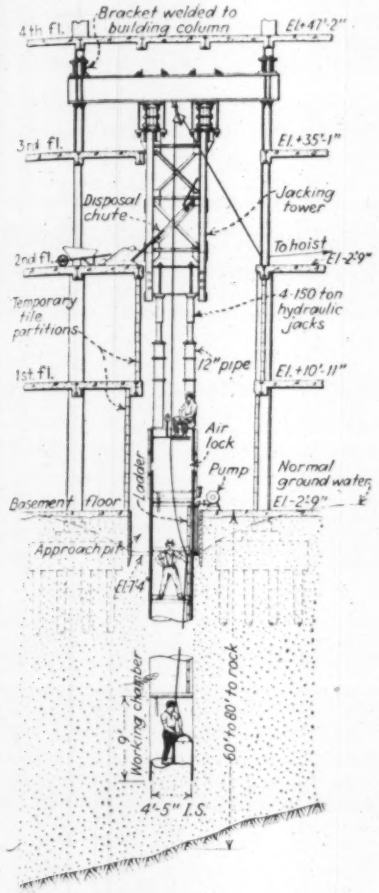


Fig. 4—Pneumatic cylinders were sunk by means of four 150-ton jacks reacting against the weight of the building through a special jacking frame.

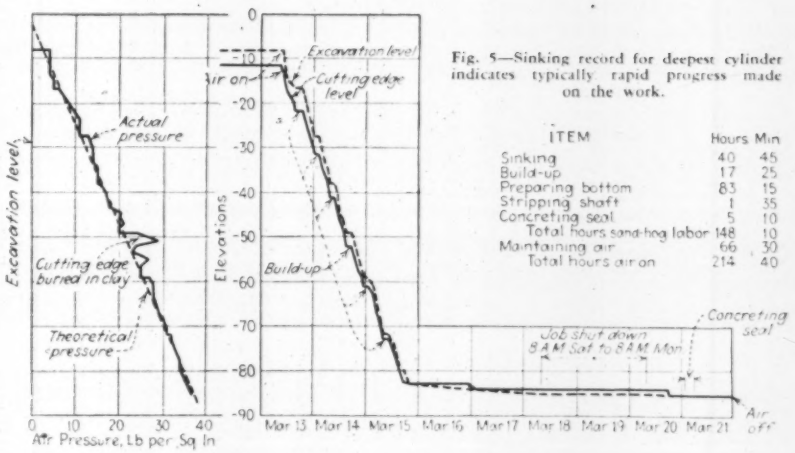

Excavation level
Air on
Cutting edge level
Actual pressure
Cutting edge buried in clay
Theoretical pressure
Build-up
Concreting seal
Job shut down 8 A.M. Sat. to 8 A.M. Mon.
Air off
Elevations
Air Pressure, Lb per Sq In
Mar 13 Mar 14 Mar 15 Mar 16 Mar 17 Mar 18 Mar 19 Mar 20 Mar 21

Fig. 5—Sinking record for deepest cylinder indicates typically rapid progress made on the work.

ITEM	Hours	Min
Sinking	40	45
Build-up	17	25
Preparing bottom	83	15
Stripping shaft	1	35
Concreting seal	5	10
Total hours sand-hog labor	148	10
Maintaining air	66	30
Total hours air on	214	40

inserted between the top of the lock and the rams. After a full 5-ft. length of cylinder had been jacked, the rams were run up, blocking removed, lock removed, and an additional section of shell bolted in place for the next jacking operation. An air-tight door was placed at the diaphragm in the top of the working chamber to maintain air pressure in the chamber while inserting a new length of shell. During this operation air was supplied to the working chamber by means of pipe and hose connections.

After experience with the first two caissons, it was decided that the time required for changing the lock and setting 5-ft. cylinder lengths could be much reduced by installing 10 ft. of cylinder at one time. This was done for the remaining six caissons.

The 500 to 600 tons resistance necessary for the jacks was obtained in Unit H by means of girders attached to the building columns, the column dead loads providing sufficient weight. In Unit G, however, the dead weight of the building was not sufficient to develop the necessary resistance, although the column sections themselves were sufficiently strong, having been designed for future upward extension of the building. In this unit, therefore, the beams supporting the top of the jacking frame were fastened to the tops of the columns to develop such load as the columns could provide, and additional load in the form of cast-iron caisson weights was placed on top of the beams to obtain the required reaction. A maximum of 90 tons of caisson weights was used for this purpose.

In order to prevent the jacks from exerting an excess pressure that might actually lift the columns of the building, a hydraulic pressure regulator, with a capacity up to 10,000 lb. per sq.in., was installed in the hydraulic line. This instrument consisted essentially of a Bourdon tube geared to an indicating pointer and also to a movable arm carrying an electric contact. The pressure regulator could be set by trial, so that at any desired pressure limit in the hydraulic line the electric circuit, through the moving arm, would be closed, actuating a magnetic circuit breaker which, in turn, would throw out one phase and thus stop the induction motor that operated the hydraulic pump. This device functioned perfectly.

The first five caissons sunk encountered rock at nearly the same level, El. —66.7 to —68.5. Comparatively little time was required for the preparation of these bottoms, as the rock was hard and comparatively level. The last three caissons (at the north end) encountered progressively worse rock conditions, and required considerable time and labor for squaring up the bottoms and bringing the cutting edges to satisfactory bearing on rock. The lowest rock encountered (at the caisson at the extreme northwest corner) was at El.—82.8, the cutting edge for this caisson stopping at El. —85.4. Rock encountered was generally a good grade of Manhattan schist except in the caisson (at the extreme northeast corner) where rock was first encountered at El.—61.7. Exploration developed the fact that this rock covered over two-thirds of the caisson area, then dropped nearly vertical for a distance of about 15 ft. to where the schist rock again leveled off. The high point of rock first encountered in this hole proved to be pegmatite granite, and is probably a laccolith or igneous intrusion between the strata of older schist. Further evidence to this effect was the presence of hornblende schist where this granite contacted the mica schist, hornblende being a metamorphic rock which might be expected under these conditions. The granite formation was extremely hard, and as the use of dynamite was absolutely prohibited on the work, its removal by plug and feather methods was a slow, tedious operation under air, particularly in the small area of the working chamber. This particular caisson was sunk to the rock, a distance of nearly 60 ft., in less than two days, while the proper preparation of the bottom on rock required about fifteen days. The rock uncovered under the caissons sloped sharply downward toward the river, indicating that this site is on the edge of the Hudson River Gorge.

The job was operated during the period of caisson-sinking on a three-shift, 24-hour basis, from 8 a.m. Monday to 8 a.m. Saturday. Except for maintaining air, the job was inactive over the week-ends. The sinking of the first caisson started Feb. 1, 1933, and the last caisson landed on rock on March 30, eight weeks later, verifying the contractor's estimated progress of one caisson per week. In order that sinking operations might be as nearly continuous as possible, duplicate jacking head, tower and overhead beams were provided, so that while one caisson was being sunk and completed, the preparation for the next caisson could be under way, permitting the sand hogs to be moved without delay from one caisson to the next. It is the writer's belief that a record sinking performance under air was attained in the course of the work, when on several occasions about 40 ft. of sinking was accomplished in a 24-hour period. Fig. 5 shows the sinking record for the deep caisson at the northwest corner.

After the bottom of a pier was passed, a concrete seal was poured under air to a height of 6 ft. above the cutting edge, where an inside girth angle was provided in the working chamber as a stop for the concrete plug thus formed. The

door at the top of the working chamber was then closed and air maintained on top of the seal, while the air lock and jacking equipment above were removed and shifted to the next caisson. After about 18 hours the pressure was removed from the working chamber, the air-tight door taken off and the balance of the pier filled with concrete.

An excavating crew consisted generally of two men within the caisson, one filling the dirt bucket and one guiding the bucket through the bottom door and acting as handy man in the hole. The outside crew on the caisson consisted of a lock tender, pressure foreman and a laborer who dumped the dirt bucket and removed the excavated material to a chute which discharged into trucks in Washington St.

Extraordinary precautions were taken to prevent inflow of material under the cutting edges, which were generally kept well buried in the soil. The air pressure in the caisson was carefully controlled so that the pressure would not be in excess of the hydrostatic head outside the caisson, as it was felt that the escape of air due to excess pressure would disturb the sand under the adjacent pile footings and possibly cause settlement of the building. That the combined efforts of all to do a safe job were effective is evidenced by the fact that the maximum observed settlement in any building column was not in excess of ¼ in., and most of the columns showed no settlement. The plumbness of completed caissons was a source of much satisfaction, as the specified limit of 1 per cent out of plumb was never exceeded, and except for one instance the caissons were plumb within 1/14 of 1 per cent of their height.

John Lowry, Inc., New York City, was the general contractor for the complete viaduct structure from the north side of Bethune St. to the south side of Bank St., as well as for building alterations. The Bell Telephone Laboratories, Inc., were represented throughout the work by W. B. Sanford, plant manager, and by Voorhees, Gmelin & Walker, architects for the building alteration. The viaduct structure was designed in the office of the chief engineer of the New York Central Railroad Co. H. J. Deutschbein Co., Inc., New York City, as subcontractor for John Lowry, Inc., constructed the foundations. Moran & Proctor, New York City, designed and supervised the installation of the viaduct foundations as consulting engineers for the New York Central Railroad. The writer was resident engineer on the work for Moran & Proctor.

Soil Erosion Service Plans Large-Scale Operations

IMPRESSIVE demonstrations of soil erosion control methods are planned by the new Soil Erosion Service set up in the Interior Department and financed by an allotment of $5,000,000 from PWA funds. Heading the new unit are H. H. Bennett, director, and W. C. Lowdermilk, vice-director.

The Erosion Service now is selecting ten or eleven watersheds of 200,000 to 300,000 acres each in various parts of the country where soil erosion is a major problem. With the cooperation of the land-owners in such areas, a variety of practical control measures, both vegetative and mechanical, will be applied according to their adaptability to conditions. Where mechanical methods are suggested, a vegetative covering also will be applied to provide full stability.

A combination of engineering, forestry and cropping practices will be employed in establishing a definite plan of land use based on the peculiar requirements of soil, topography, rainfall and type of agriculture in each area. The areas selected are representative of the diverse conditions under which soil erosion has already acted, destroying 35,000,000 acres of land formerly cultivated and progressively impoverishing 125,000,000 acres in the United States.

The areas selected for the demonstration programs are located as follows:

Upper Mississippi Valley near La Crosse, Wis.: unglaciated region covered with wind-blown soil.

North central Missouri and south central Iowa: glaciated soil.

Central Illinois: high-grade land washing very rapidly.

Southern Illinois: severely croded land representative of conditions on 10,000,000 acres in Illinois, Indiana, Ohio and Kentucky.

Black belt of Texas.

South Carolina Piedmont region, near Spartanburg.

Palouse wheat belt near Pullman, Wash., extending over into Idaho.

Bean belt of Southern California.

Red plains of Oklahoma, near Stillwater.

Navajo and Hopi reservations in Arizona, New Mexico and Utah, so badly over-grazed that the rapidly increasing Indian population is on the point of dispersing.

A tract in the Tennessee Valley may also be included. Regional directors will be appointed who are resident in the locality and have practical as well as college training in agriculture. The regional staffs will include agronomists, agricultural engineers, foresters and possibly gamekeepers. Mr. Bennett anticipates that in some regions essential control measures will reduce the cultivated area, and he regards the propagation of wild fowl as a happy method of compensating the farmers.

Cooperation of 50 per cent of the land-owners in a given area is sufficient, in Mr. Bennett's opinion, to assure success of the erosion-control demonstration. In Wisconsin, where plans have been carried further than in the other regions, a canvass indicates cooperation of 90 per cent of the farmers. Many farmers in that region now are following strip-cropping, a practice that enormously reduces erosion by sandwiching thick crops such as alfalfa between corn and other clean-till crops.

In combining vegetative with engineering methods of checking land depreciation, the present emphasis appears to be on the former, but Mr. Bennett states that mechanical methods developed at the erosion-control experiment stations of the Bureau of Agricultural Engineering will be applied in the larger demonstration program. In addition to regular appropriations, allotments of $57,750 have been made to date by the Public Works Administration for continuing the erosion-control experimental work of the engineering bureau headed by S. H. McCrory and the Bureau of Chemistry and Soils. The Bureau of Plant Industries has received an allotment of $630,000 to establish nine erosion-control nurseries for propagating trees, bushes, plants and grasses adapted to checking the progress of soil erosion. The nurseries will be located at Mandam, N. D., Woodward, Okla., Cheyenne, Wyo., Elsberry, Mo., Silverhill, Ala., Hays, Kans., North Platte, Neb., Ames, Iowa, and a location in North Carolina.

Highway and Motor-Vehicle Statistics for 1932 in Canada

Highways in Canada constructed during 1932 cost $45,857,491. The surfaced mileage at the end of the year was 91,312, while unsurfaced mileage amounted to 307,005. Gravel roads increased from 75,081 to 80,183 miles. Cement-concrete roads showed an increase of 433 miles—from 1,584 to 2,017 miles.

Motor vehicles operated in the Dominion during the year brought taxes of $56,700,000. The Provinces collected $21,126,271 in registration fees and $27,083,316 in gasoline taxes. The Dominion government took $508,471 in import duties and excise taxes; the sales taxes on cars sold amounted to $2,500,000; and import duties on gasoline were $1,500,000. The number of motor vehicles registered was 1,114,503, or one vehicle to each 9.4 persons in Canada.

Designing and Operating a Small Sewage Plant

Salient features of design and results of operation of a modern plant for treating the sewage from a state institution

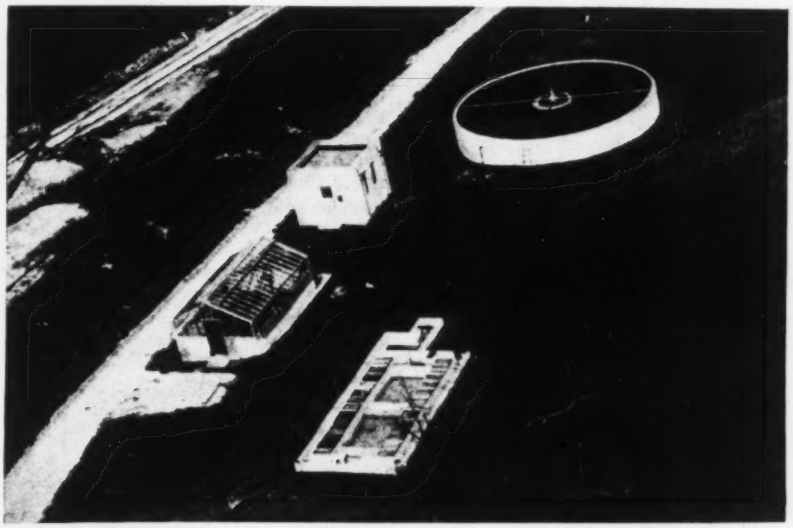
By Lynn J. Arthur
Jeup and Moore, Consulting Engineers, Indianapolis, Ind.

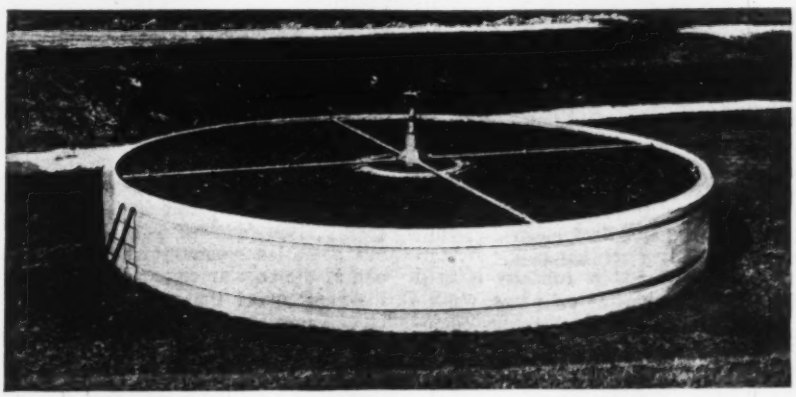
TWO YEARS AGO there was designed and constructed a small plant to give complete treatment to the sewage from a state institution in Indiana housing about 500 persons. The plant includes an Imhoff tank, dosing chamber, trickling filter, secondary-settling tank and a glass-covered sludge bed. Records of operation have been carefully kept since the plant was put in service in December, 1931. Published material on sanitary installations of this magnitude is not plentiful, and, therefore the following article has been prepared, discussing the design, costs of construction and the results of one year's operation of this plant.

The purpose of the plant is to treat the domestic sewage of the Indiana Girls' School to prevent pollution of the open ditch running through the grounds and the waters of near-by Eagle Creek. It replaces an old Imhoff tank plant, built eighteen years previously, which was becoming obsolete and was in need of extensive overhauling. Conservative estimates indicated that the cost of making the necessary repairs and additions would be nearly as great as the cost of a complete new plant, so that the trustees authorized the new construction.

Upper view—Sewage-treatment plant for the Indiana Girls' School includes Imhoff tank, trickling filter, secondary settling tank, glass-covered sludge-drying bed and chlorination equipment.

Lower view—Circular trickling filter with revolving distributor.





Design

In 1931 there were about 500 persons at the institutions, including inmates, officers and employees, and the population had been increased slowly during the past fifteen years. To provide for a reasonable growth within its economic life, the plant was designed for 700 persons. The rate of sewage flow, as characteristic of most institutions with scheduled operations, fluctuates greatly—from 5 to 75 gal. per minute during summer dry weather—with more than 90 per cent of the flow occurring between 5 a.m. and 9 p.m. The average daily flow amounts to 35,000 gal., or 70 gal. per capita daily. Although sewers are of the separate type, considerable infiltration occurs during wet weather, entering the old main sewer through joints in its upper course. For design purposes, the average daily flow was estimated at 100 gal. per capita, or 70,000 gal. daily. Assuming the entire flow during 16⅔ hours, the figure of 70 gal. per minute was decided upon for use in tank design.

The sewage includes all laundry wastes of the institution and is considered as medium to strong.

Plant Units—The site selected was on a hillside, making possible a plant layout requiring only 500 cu.yd. of excavation.

The plant provides for preliminary settling in an Imhoff tank, followed by biological treatment in a trickling filter and final settling in a secondary-settling tank. Chlorination is added during the summer months to protect bathing beaches on Eagle Creek. Imhoff tank sludge is dried on covered beds. Bar screens at the entrance of the plant were not considered necessary because of the strict control maintained over the kind of refuse permitted to be discharged into the sewer. Any unit of the plant, with the exception of the dosing chamber, may be bypassed.

There were 11 ft. of head available for use in plant design. This permitted a gravity design except for the removal of sludge from the secondary settling tank. The units of the plant were located with a view to increasing the capacity by the construction of additional or duplicate units in the future, should the school have an unexpected growth.

Imhoff Tank—A single Imhoff tank of the reversible-flow type, rectangular in plan, was adopted. At a sewage depth of 7.0 ft., at rated capacity, this chamber provides for a detention period of 1½ hours. The digestion chamber was designed on the basis of 2 cu.ft. per capita. This capacity is measured from a plane 20 in. below the point of intersection of the sloping sides of the

sedimentation chamber. Sludge flows under a 5-ft. head from each hopper through a 6-in. sludge pipe to the drying bed.

A flushing pipe in each hopper bottom, with a riser pipe extending to the top of the tank to which water pressure can be connected, is provided for the purpose of loosening the sludge.

Sewage enters and leaves the Imhoff tank over submerged weirs. In the bottom of the sewage channel, at each entrance to the Imhoff tank proper, there is a tapered slot, 6 in. wide, through which any solids failing to pass over the entrance weir may settle into the lower part of the sedimentation chamber and thence into the digestion chamber. The elevation of both weir plates is the same and is such that sewage will discharge over the weir and not upward through the slot.

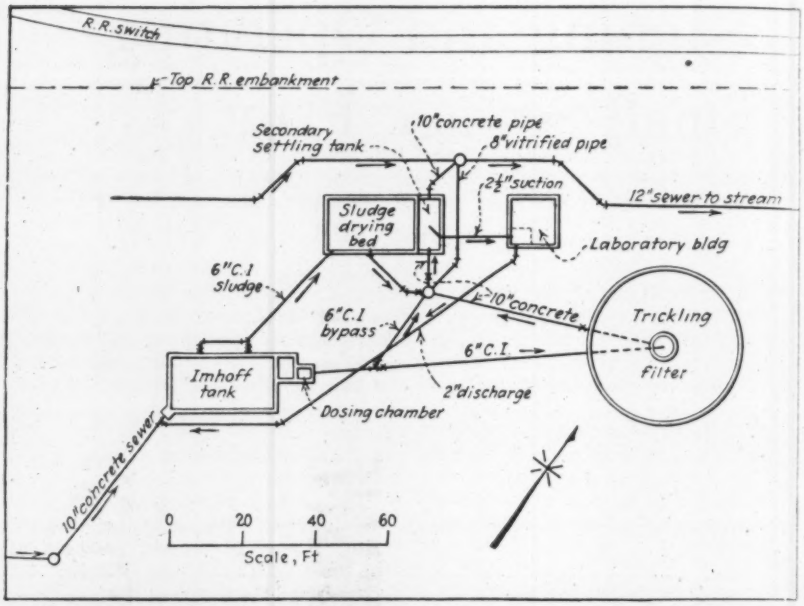
Sludge Bed—A substructure of reinforced concrete supports a glass superstructure of the ventilating type. The design capacity of the bed is 0.4 sq.ft. per capita. It consists of graded sand and gravel placed over an underdrain system of vitrified pipe. The 4-in. layer of sand on top of the bed will pass a ¼-in. screen and be retained on a 16-mesh screen. The sludge inlet piping consists of three 6x4-in. vitrified T's in a 6-in. vitrified header line embedded in one side wall. A splash slab of concrete is placed under each outlet to prevent scouring away of the sand bed.

A main walk, 24 in. wide on the longitudinal center line and supported on concrete piers, will accommodate a wheelbarrow used in removing dried sludge. Oak-plank cross-walks, 14 in. wide, provide access to the side-wall ventilating controls.

Dosing Chamber and Siphon—The dosing chamber, built adjoining one end of the Imhoff tank, is supported by beam construction from the main wall of the tank to firm footing in the natural bank. The capacity of the dosing chamber is 250 gal., which at a flow of 70 gal. per minute will require about 3½ min. to fill. The siphon is of the low-draught type, 6x4 in., operating under a total head of 2.5 ft.

Filter—The trickling filter is circular and is equipped with a rotating distributor. This distributor consists of four perforated-pipe arms that revolve about a central column when the sewage is released from the dosing chamber. The holes in each arm are so spaced and staggered that any one spot on the bed is dosed only once per revolution. The reasons for adopting this type of distributor rather than fixed nozzles were chiefly the small amount of head available, the lower cost and the small amount of attention required with this equipment.

The filter material consists of 6 ft. of crushed limestone, passing a 2½-in. and retained on a 1½-in. screen. The filter has a capacity of 4,200 persons per acre per foot of depth for the design population of 700. Design was made on this basis rather than upon the basis of nitrogen load or B.O.D. because of lack of time to make the tests necessary in the latter method.



Plan of sewage-treatment plant at Indiana Girl's School, which includes a reversible-flow Imhoff tank and a circular trickling filter equipped with a rotating distributor arm.

The underdrain system is of vitrified block laid on a concrete floor.

Secondary Settling Tank—Built of reinforced concrete, rectangular in plan, the secondary-settling tank provides a detention period of 45 min. at design flow, with an allowance of 1½ cu.yd. per m.g. of weekly flow for sludge. Baffles of 3-in. cypress are provided at both ends: at the inlet end to check the velocity, and at the outlet end to retain floating matter. The bottom is hopper-shaped, with a slope of 2 horizontal to 1 vertical. Sludge is removed by pumping through a 2½-in. galvanized-iron suction pipe and discharging through a 2-in. galvanized-iron pipe to the sewer line near the entrance to the Imhoff tank.

Laboratory Building—The laboratory building houses the sludge pump, chlorinator and laboratory. It is of reinforced concrete throughout and is electrically lighted, steam-heated and provided with running water under pressure. The sludge pump is placed in a pit with starting switch and speed-control box conveniently located near the door. The chlorinator is housed in a separate room. The chlorine solution runs through a special hose laid in 2-in. galvanized electric conduit to the secondary settling tank. A platform scale of 500-lb. capacity is used for weighing chlorine cylinders.

The chief items of laboratory equipment are an enameled sink, drain board, wood cabinet, chlorine comparator, Imhoff glasses and rack for settleable-solids tests, glass-stoppered bottles for methylene blue tests and other miscellaneous small articles.

Construction began Aug. 31, 1931, and was essentially complete on Nov. 6.

The total cost of the plant, including engineering fees and all equipment, was $13,960. This included equipment purchased direct by the institution. It amounts to slightly less than $20 per capita of design. Because of unforeseen soil conditions, an extra was allowed the contractor for wider footings under the filter, sludge bed and laboratory building and a concrete mat under the secondary settling tank.

The cost of the various items as set out in the successful bid follows:

Imhoff tank and dosing chamber	$2,308
Trickling filter, exclusive of revolving distributor	2,435
Sludge-drying bed and secondary settler	1,147
Glass superstructure for sludge bed	815
Laboratory building, exclusive of pump and motor, and chlorinator	1,378
Piping	1,158
Tools and laboratory equipment	120
Approved extras	314

Items of equipment furnished by the institution cost as follows:

Chlorinator	$732
Sludge pump and motor	93
Filter distributor and siphon	1,440
Miscellaneous materials, chiefly water and steam lines	469
Miscellaneous labor, estimated	50

The general contracor was Marshall L. Oberholtzer, Indianapolis.

Operation

The plant was placed in operation on Dec. 7, 1931, and has been in continuous operation since. It is attended by one of the regular employees who does his work under the supervision of the chief engineer of the institution. This operator spends from 30 to 45 min. each day for six days a week, and from three to four hours on the seventh day.

Every day the operator notes and records the following: the weather condition, wind direction, stage of Eagle Creek, time spent at the plant, depth of scum in the Imhoff tank, distance from bottom of slot to top of sludge, percentage of sludge-drying bed area not in use, number of filter distributor openings cleaned, air temperature, temperature of raw sewage, settleable solids in the Imhoff tank influent and effluent, in the filter effluent, and in the plant effluent, pH of the raw sewage and of the final effluent, pH of the sewage in the Imhoff tank at the slot line and of the sludge in the hopper bottoms, and the relative stability of the plant effluent. Each day he squeegees the tank walls and slots, skims off the tanks and breaks up the scum in the gas vents; these items appear on the report sheet and must be checked off as completed. When the chlorinator is in use, he weighs and records daily the amount of chlorine used.

The facts and figures presented in the following paragraphs are the results of a study of the operator's reports for the year February, 1932, through January, 1933.

Handling Imhoff Tank Sludge—In November, 1931, preliminary to putting the plant in operation, the Imhoff tank was "seeded" with sludge pumped from the old Imhoff tank. No measuring device was at hand, and, due to lack of close attention, an excessive amount was used. After five months' operation, the accumulated sludge had risen to the slot and had begun to appear in the upper chamber. To relieve this condition, five applications of sludge were drawn off to the drying bed in rapid succession, each being allowed to dry only from seven to thirteen days, and removed as soon as possible to make way for the next application. By the middle of June, 1932, the drying process had caught up with the sludge production, and drying was accomplished satisfactorily, each application remaining on the bed from three to four weeks.

Experiments with sludge applications at various depths between 6 and 14 in. indicated that the best results were obtained at the shallower depths, not to exceed 10 in. Stirring the applied sludge every few days has been found to hasten drying. When dried, the sludge is shoveled out and applied as fertilizer on the institution grounds.

Imhoff Tank—The depth of scum in the gas vents runs uniformly about 2 in. Scum is kept under control by forcing it down every day with a stream of water through a hose. During the month of April, 1932, when the plant was behaving abnormally due to the overloading of the sludge chamber, several times the scum rose as much as 15 in. above the liquid level, but it has never overflowed the tank or caused serious trouble.

During the abnormally cold weather of December, 1932, the stability of the plant effluent dropped to one day for five successive days. This was believed to be due to the fact that the surface of the gas vents becomes frozen. Woodbatten covers were installed on the third day, and three days later the plant effluent was again back to normal. Sewage flow is reversed once a month.

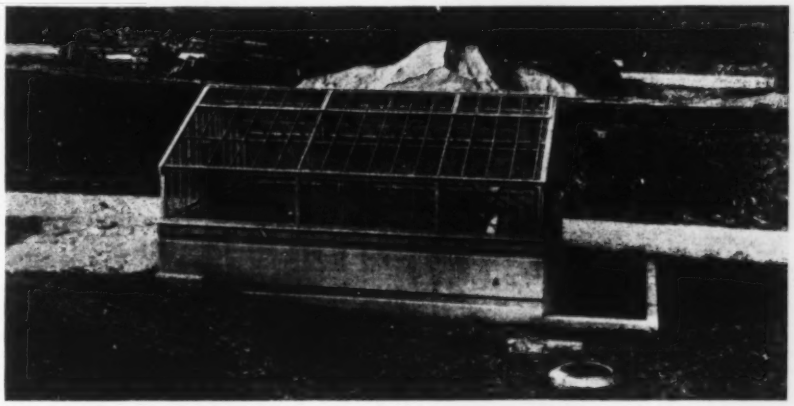
Filter and Distributor—The holes in the filter distributor arms occasionally become clogged, and the operator gives attention to this feature each day. Once a week the shear gate on the end of each arm of the distributor is opened, and the rush of sewage is allowed to flush the entire pipe arm.

In dry seasons the sewage flow is so low during the night that the filter distributor stands idle for long periods. During one night in March, 1932, when the temperature was between 5 and 10 deg., the distributor froze. After that, kerosene was used in the air-lock seal during cold weather. This prevented freezing at a temperature of 6 deg. below zero, but was unsatisfactory except as a temporary measure because the kerosene gradually worked out and appeared in the secondary settler. In December, 1932, a steam heater made of coils of 2-in. pipe was installed in the center well around the distributor and was connected to a steam pipe extended from the laboratory building. While there has been as yet no extremely cold weather to test this device, it is expected to prevent freezing of the distributor at the lowest temperatures that have been known in the region.

Unloading of the filter was pronounced for several days during the middle of May, 1932, and it also occurred, but was less noticeable, at intervals during September and October.

Secondary-Tank Sludge—Sludge is pumped several times a week from the secondary settler to the sewer line at the entrance of the Imhoff tank. The pump first installed, of the open-impeller type with 1½-in. suction and discharge openings and with a rated capacity of 30 g.p.m., proved to be unsatisfactory for handling this secondary sludge, which had a specific gravity of 1.034 with 91.4 per cent moisture. The pump company therefore replaced it with a larger centrifugal pump of the open-impeller type with 2-in. suction and discharge openings. It is driven by a 1½-hp. variable-speed motor and has a rated capacity of 75 to 100 g.p.m. It has been in use since October, 1932, giving satisfactory service. While the pump is running, the operator gently squeegees the sludge down the sloping hopper bottom to the outlet pipe. This is done without any perceptible sludge appearing on the surface and assures complete cleaning of the tank at each pumping.

Chlorinator—The chlorinator was in constant service from May 12 to Oct. 16, using an average amount of 2.0 lb. of chlorine per 24 hours. Chlorine is



Glass-covered sludge-drying bed. The secondary settling tank is at the right end of the bed.

SETTLEABLE SOLIDS REMOVED BY IMHOFF TANK

Average Month	Present in Raw Sewage C.C. Per Liter	Removed by Imhoff Tank C.C. Per Liter	Per Cent Removed	Present in Raw Sewage C.C. Per Liter	Removed by Imhoff Tank C.C. Per Liter	Per Cent Removed
1932	On Laundry Days			On All Other Days		
Feb.	4.64	4.51	97.2	2.12	2.05	96.7
Mar.	4.39	4.32	98.4	3.48	3.42	98.3
Apr.	Data not taken			3.89	3.63	93.3
May	4.53	3.33	73.5	2.58	2.07	80.2
June	4.61	3.22	69.8	1.75	1.58	90.3
July	5.24	3.10	59.2	2.52	2.34	92.9
Aug.	4.45	2.74	61.5	2.17	1.61	74.2
Sept.	8.88	6.89	77.5	3.31	3.47	74.6
Oct.	9.39	6.52	69.4	5.41	4.56	84.3
Nov.	6.38	3.97	62.2	6.68	5.44	71.4
Dec.	4.19	3.01	71.8	4.11	2.27	55.2
1933						
Jan.	4.01	2.98	74.3	4.11	3.41	83.0
Average	5.52	4.05	73.4	3.51	2.90	82.6

applied at the influent end of the final settling tank. Unfortunately, there is no device for measuring the sewage flow; however, on the basis of the estimated present flow of 50,000 gal. daily, the chlorine used is 38.6 lb. per m.g., with 0.35 p.p.m. chlorine in the effluent.

Plant Efficiency—The efficiency of the Imhoff tank, as measured by the percentage of total settleable solids removed by the Imhoff cone method, is given in the accompanying table. Due to the fact that the load on the plant is considerably higher on wash days, Monday and Thursday, data for these days are set out separately. It is interesting to note that while the load was 57 per cent greater on wash days than on other days, the efficiency of the Imhoff tank dropped only 11 per cent.

While the test for relative stability (methylene blue) showed that on 61 days of the year, or for 17 per cent of the time, the stability of the effluent was less than the standard of five days, operation has been improving constantly with experience, and it is believed that this figure can be improved considerably in the future.

The daily pH of the raw sewage varied between 7.3 and 8.4, averaging 7.6. The pH of the final effluent varied between 7.4 and 8.0, averaging 7.7. The pH of the Imhoff sludge varied between 7.0 and 8.6, averaging 7.5.

With a view to improvement in future projects, the following suggestions and comments are made:

1. The addition of a sump in the bottom of the secondary settling tank would facilitate thorough cleaning of the hopper bottom.

2. A device for measuring the amount of daily sewage flow, and if possible the rate of flow, is highly desirable in order to interpret the operating results intelligently and correctly.

3. During construction, in pouring concrete in sloping baffle walls (or other walls with vertical angles) "honey-combing" may be more readily avoided by omitting temporarily one form board at the angle in the wall to allow rodding of the concrete.

4. A tool box built of concrete and located near the tank, providing a permanent receptable for the various tools used in skimming, cleaning and in taking measurements, would prolong the life of the tools and improve the appearance of the grounds. Such a box has been designed for the above plant but has not yet been built.

The writer is indebted to George A. Berry, chief engineer of the Indiana Girls' School, for supplying information concerning the operation of the plant and for his constructive criticism during construction.

Partition Walls of Culverts Designed as Brush Collectors

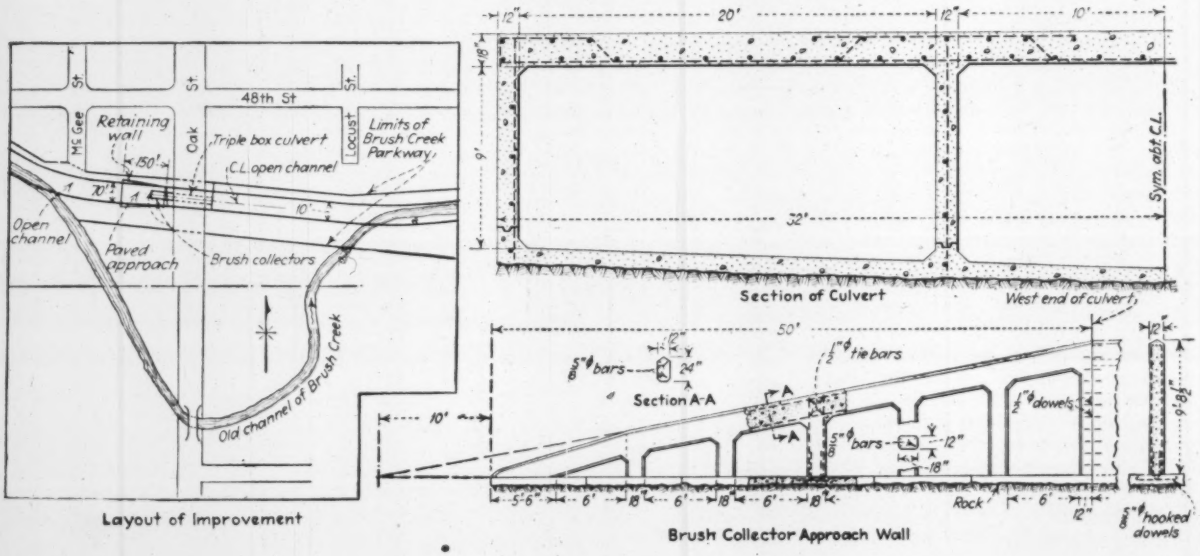
ONE of the important relief projects carried on in Kansas City, Mo., during the past year was the straightening and paving of a meandering stream known as Brush Creek. For the greater part of the length, banks were riprapped on a 1½ to 1 slope, but at street crossings the creek was confined in box culverts of concrete varying in width from 60 to 70 ft. and in depth from 10 to 15 ft. These culverts represent a contraction in stream cross-section and, since considerable driftwood is carried at time of flood, some effort seemed necessary to keep log jams from forming. O. M. Nichols, assistant sewer engineer in the public works department, conceived the simple idea of extending the culvert division walls upstream for a considerable distance, at the same time sloping the top edge of the walls down to a junction with the bed of the stream. Logs too long to pass through the culvert openings sideways ride up this incline. When the flood passes, they can be removed. Such logs, brush and driftwood as may accumulate do not stop the creek flow because they ride on top of the water. As the water stage rises, the driftwood is pushed farther up the inclined wall.

At 49th and Oak Sts. (see drawing) a triple box, 64 ft. wide over-all, is utilized. Division walls are 21 ft. apart center to center. The two center walls are extended upstream a distance of 50 ft., on a down slope of about 1:5. Equalizing openings are provided through these partition walls in order to maintain a fairly uniform velocity in all culvert openings.

A flood of sufficient magnitude to test the theory of these brush collectors has not yet occurred. But in a few cases of medium high water the brush has been handled in such a way that a fair degree of success seems assured.

Matthew S. Murray is director of the public works department of Kansas City, Mo., which carried out the Brush Creek improvement.

In box culverts used along new straightened channel of Brush Creek in Kansas City, Mo., partition walls were extended upstream to serve as brush collectors. During floods the driftwood rides up the inclined wall instead of blocking the culvert openings.



Monolithic Tier Buildings for Beer Storage

Unique concrete structure being built in Brooklyn follows a special European design in which the rooms of the building, lined with a paraffin material, serve as storage tanks

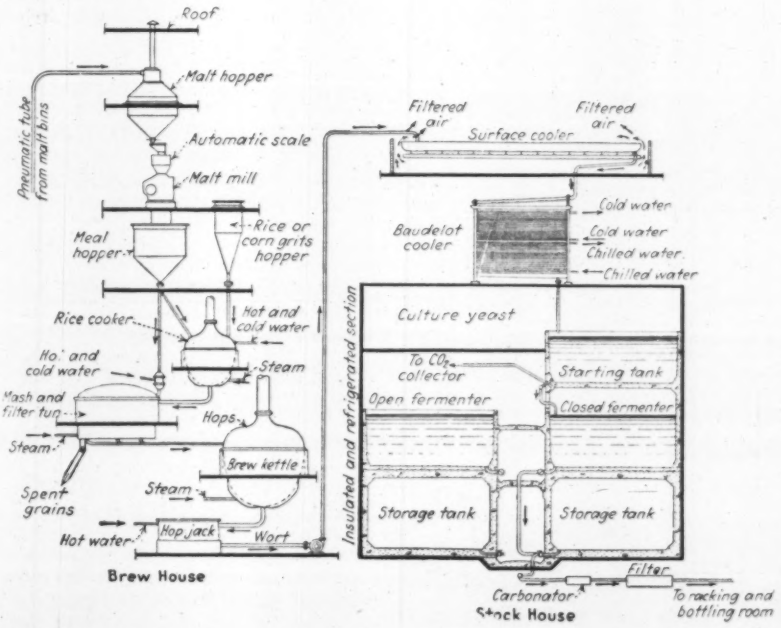
By Godfrey Lutz
Chief Engineer, Turner-Rostock Corp., New York, N. Y.

CONSTRUCTION of a new stockhouse at the plant of the F.&M. Schaefer Brewing Co. in Brooklyn, N. Y., marks the introduction in this country of a special design built entirely of reinforced concrete which has been used extensively in Europe since the war. Briefly the new structure (Fig. 2) is a monolithic concrete building of eight stories in which the stories themselves comprise the beer fermentation and storage tanks, which are lined with a special paraffin-base material that is not affected by the beer and is itself tasteless and odorless. The structure is designed as a series of rigid frames in which tensile stresses predominate. Due to the compactness of the tank layout, the space required for aging 1 bbl. of beer amounts to only two-thirds of that required for storing in other types of tanks. A corollary of the space saving is the saving effected in refrigerating costs, since a minimum surface area of walls and roof is exposed to the air temperatures. While the Schaefer installation providing for 65,000 bbl. of storage is the first in this country, some 300 similar structures with a total capacity of more than 2,000,000 bbl. are located in various countries, mostly in Europe and largely in Germany, France and Austria.

Brewing procedure

Assuming that a brewery buys its malt, it performs two main manufacturing operations: (1) brewing, which takes place in the "brew house"; and fermentation followed by aging, which is done in the "stockhouse." The typical flow sheet (Fig. 1) shows these two operations. In the stockhouse, after passing over coolers, the wort is piped to the starting tank, where yeast is added and fermentation started. After a 12- to 24-hour stay in this tank, the wort is transferred to the fermentation tank, where the fermentation process—part of the sugar (maltose) being transformed into alcohol and carbonic acid—is completed in from 8 to 12 days at a temperature of about 40 deg. F. The young beer then passes through a process of after-fermentation and aging in storage tanks for a period varying from six to twelve weeks at a temperature of about 34 deg. F. The final operation involves filtering and bottling or placing in kegs.

Fig. 1—Typical brewery flow sheet, showing how the stockhouse fits into the series of operations.



Concrete stockhouse history

In former years beer was fermented, stored and aged in wooden tubs and casks placed in vast underground vaults that were refrigerated by melting ice stacked in adjoining rooms. Advanced knowledge of the insulating value of various building materials, such as cork, the introduction of refrigerating machinery and the progressive use of steel in building construction and for the fabrication of tanks brought the first important change in stockhouse design. Instead of digging cellars, tall buildings were erected into which were placed, as formerly into the vaults, wooden tubs and casks, or more recently pitch-lined or glass-lined steel tanks of horizontal cylindrical form. Finally, toward the end of the last century, reinforced concrete entered the field of brewery construction, although its use for fermentation and storage tanks in stockhouse construction at the beginning encountered obstacles in the following requirements:

1. The highly deteriorating effect of the beer on the concrete had to be prevented by invention and application of a suitable permanent lining capable of withstanding the effect of changing temperatures near the freezing point, at the same time imparting neither taste nor odor to the beer.

2. Such tanks are subject most of the time to an internal pressure of 3½ to 5 lb. per sq.in. of carbonic acid, which pressure is increased to 12 lb. per sq.in. (1,730 lb. per sq.ft.) for the purpose of drawing the beer from the tanks. As a loss of pressure would render the beer flat and unsuitable for consumption, the formation of even the smallest cracks had to be prevented by proper design, involving highly statically-indeterminate systems and careful erection methods in the field.

After prolonged and costly experiments beginning about 1903, a suitable lining, with paraffin as the basic material, was perfected which was neutral to the action of beer and at the same time was tasteless and odorless. The application of the lining involves several operations: coating of the tank surfaces with a porous plaster coat, drying of the concrete structure and the plaster coat by means of coke salamanders, steam coils or warm air, and finally brushing on of the hot paraffin coating material. The latter penetrates the porous plaster base, has no joints and is built up to a smooth, black and glossy finish. Concrete structure, plaster and coating form a monolithic whole, with uniform expansion and contraction coefficients. Invention and development of this lin-

ing is largely due to R. Rostock, of Vienna.

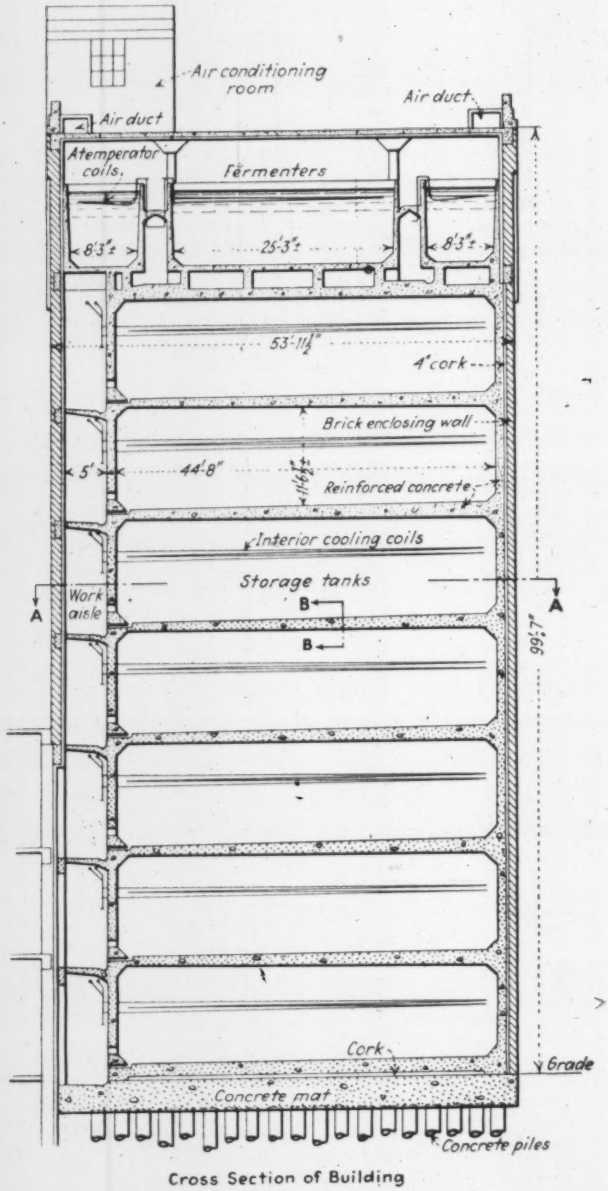
At first, horizontal cylindrical tanks of such materials as steel and wood were imitated in concrete. Competition with tanks of steel and other materials soon required, however, that full advantage be taken of reinforced concrete as a construction material. Through the adoption of rectangular tank sections and the arrangement of the tanks in tiers, it was possible to obtain a maximum utilization of space combined with a minimum outlay for the building housing the tanks. The building was reduced to a mere shell of cork and brick veneer supported by the tank structure itself (Fig. 2). Beer fills every inch of space in the storage section of the structure with the exception of a few narrow work aisles. Operation of the installation is simplified. Beer pipe lines, which have to be frequently cleaned and sterilized, and other pipe lines are shortened and, through the absence of any inaccessible corners or hidden parts of the structure, the installation is made more sanitary.

Design considerations

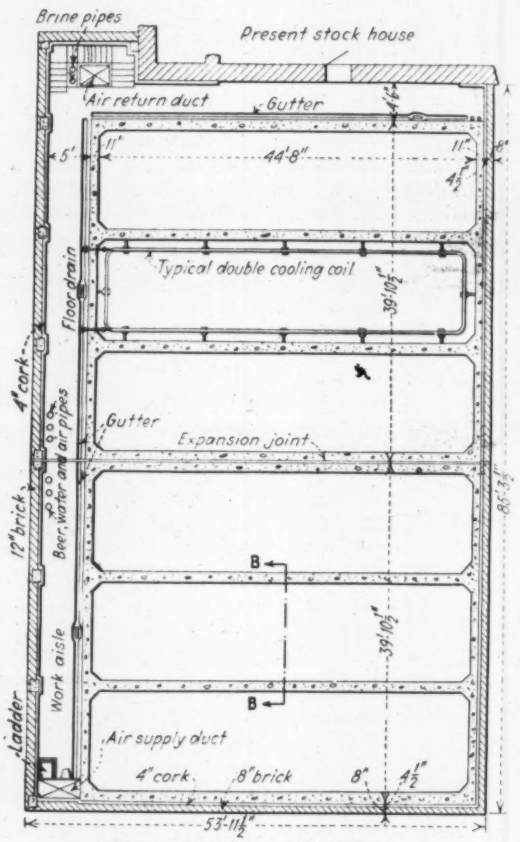
In reinforced-concrete tanks of this type it is essential that proper design methods be used. During most of the period of aging the beer the storage tanks have to withstand an inside gas pressure in addition to the weight of the fluid itself. The gas pressure is regulated by an automatic blow-off called the bunging apparatus. It is absolutely essential that this pressure of 3½ to 5 lb. per sq.in., under which part of the developed CO_2 is slowly assimilated by the beer, be maintained, and it is further necessary that the tanks withstand the increased internal pressure of 12 lb. per sq.in. (1,730 lb. per sq.ft.) when the ripe beer is drawn from the tanks. There exist very few if any requirements in reinforced-concrete design and construction more exacting than gas-tightness. A small crack will cause the tank to lose its pressure, and the contents have to be pumped into another tank at once if deterioration is to be prevented.

These tank structures are computed as multiple rigid frames, using the theory of elasticity, with due regard to the variation in the moments of in-

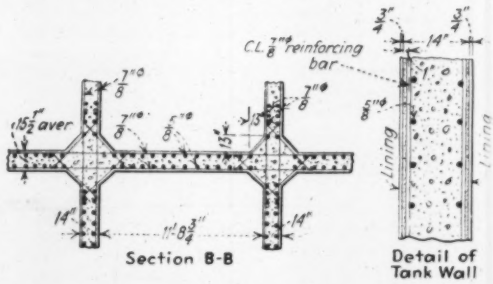
Fig. 2—Seven tiers of concrete storage tanks and a tier of fermenting tanks comprise the new stockhouse of the F. & M. Schaefer Brewing Co. The building is about 54x85 ft. in plan and 100 ft. high. It is designed as a series of rigid frames, with a high percentage of reinforcing steel and a careful mix design to assure gas-tightness under pressures as high as 12 lb. per sq.in.



Cross Section of Building



Plan A-A of Storage Tank Tier



Section B-B

Detail of Tank Wall

ertia and the most unfavorable load conditions. Most sections of the members are subject to bending and direct tensile stress. Further tensile stresses are of dominating importance, so that a mere computation of the reinforcing to satisfy code requirements is not sufficient. The amount of cement used, the water-cement ratio and the amount of reinforcing steel all must be carefully considered if the tensile stresses are to be limited properly. While the

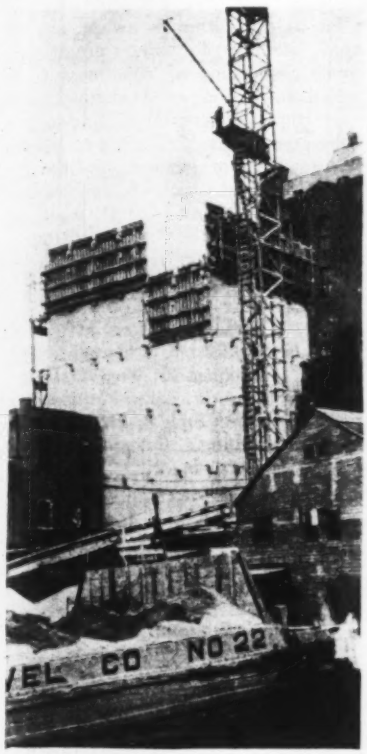


Fig. 3—Monolithic concrete stockhouse for beer storage, under construction in Brooklyn, N. Y.

influence of the first two items on concrete tensile strength are well known, less attention has been paid to the influence of the amount of reinforcing steel. It is, however, an established fact brought out by many years of successful experience with this type of tank that an increased amount of reinforcing steel permits the use of higher allowable concrete tensile stresses. While ordinary concrete structures contain about 1 per cent of reinforcing steel, 2 to 3 per cent is common in beer-tank construction.

Equally important in practice is the correct placing of the reinforcing steel. It is desirable in structures of this type to place the reinforcing steel as near as possible, approximately within ½ in., to the concrete surface. This is in line with the results of actual experience and tests by concrete investigators, which show that cracks tend to appear where the reinforcing steel is buried too deep. The ½-in. covering is permissible in stockhouse tanks such as are being installed by the Schaefer company, as the lining provides an additional ¾ to 1 in. of cover, while the danger of fire in a beer tank is extremely remote if existent at all.

In order to prevent cracks due to shrinkage, temperature and settlement stresses, it is desirable that tank structures greater than 50 ft. square be divided up into smaller independent blocks that are free to settle, expand and contract. The danger of cracks from these forces, if proper care is taken, is exceedingly small, as the cellular structure, by virtue of the restricted dimensions of the single cells and the very high amount of reinforcing steel, is extremely rigid and can withstand considerable movement.

The Schaefer stockhouse

The new stockhouse for the F. & M. Schaefer Brewing Co. adjoins the present old stockhouse and is about 54x85 ft. in plan and 100 ft. high. It has a storage tank and fermenter capacity of 65,000 bbl. of beer. There are seven tiers of storage tanks, each tier containing six 1,400-bbl. tanks 44 ft. 8 in. x11 ft. ¾ in. in plan and 11 ft. 6½ in. high, with 5-ft.-wide work aisles along the front ends of the tanks. The fermenter floor contains fermentation tanks of a total capacity of 6,000 bbl. with lower and upper work aisles. Although under average circumstances central corridors between two rows of storage tanks give a more compact and economical layout, the special local and operating conditions of the existing Schaefer plant led to the adoption of the side corridors.

The total weight of the eight-story concrete building, including foundation, when filled with beer is 19,500 tons. On account of unfavorable soil conditions, the structure is founded on an independent 4-ft. reinforced-concrete mat supported on 653 concrete piles. Concrete compressive and steel tensile stresses for mat and tanks are figured in compliance with the New York building code. An expansion joint divides the structure in two blocks of 21 storage tanks each. Insulation from outside temperature is provided by an 8-in. or 12-in. brick veneer backed by two layers of 2-in. cork.

Access to the interior of each storage tank is gained from the work aisles through a manhole. The tank floor of each tank slopes toward the work aisle, reaching its lowest point at the draw-off cock; the tank ceiling, however, rises toward the work aisles, reaching its highest point at the bung fitting where the CO_2 is collected and conducted towards the bunging apparatus.

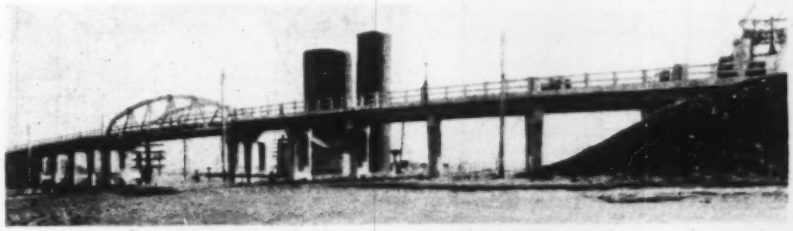
The storage tanks as well as the fermenters contain interior copper cooling coils that permit individual temperature control of each tank. The cooling medium is an alcohol-water solution, which in turn is cooled to operating temperature in two shell-and-tube coolers by the brewery's present direct-expansion ammonia cooling system. The storage-tank corridors and the fermenter room are separately cooled by two air coolers located in a penthouse. The work-aisles serve simultaneously as work-aisles and horizontal ducts into which air is forced from a vertical duct at one end of the corridor and exhausted through a vertical duct at the other end of the corridor.

The Turner-Rostock Corp., New York City, has the contract for this stockhouse. Waldemar Mortensen is the architect, and James E. Geissberger is the consulting engineer.

Grade Separation on a 54-Deg. Skew

FROM an economic standpoint, the grade-separation effected with the main-line tracks of the Santa Fe Railway at Ottawa, Kan., is one of the most important completed this year by the Kansas highway department. This highway carries two major routes, US 50S and US 73W. At times of high water in the near-by Marais des Cygnes River, the crossing was often impassable. At all times it was extremely dangerous.

New grade-separation structure and fill at Ottawa, Kan., raises federal highway routes above flood levels.



Technically, the new overcrossing is interesting because of its extreme skew of 54 deg. The structure, carrying a 24-ft. roadway, consists of a 125-ft. pony-truss span with six 30-ft. concrete girder spans at either end. The trusses, which weigh 25 tons each, were assembled complete at the shops of the Kansas City Structural Steel Co., transported to Ottawa and erected with two locomotive cranes. Ezra W. King was the general contractor, and Rex Lucas was resident engineer for the state highway commission.

Separate Roughness Coefficients for Channel Bottom and Sides

When the bottom and the sides of an open channel are of different degrees of roughness, the equivalent coefficient for the channel as a whole varies with the depth of flow

By Robert E. Horton
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IT OFTEN HAPPENS that the bottom and sides of a channel are of different materials or otherwise so constituted as to have different degrees of roughness—for example, drainage ditches in earth, the bottoms of which are clean and the side slopes covered with vegetation. In this case the side roughness is greater than the bottom roughness, and the value of Kutter's or Manning's n deduced from experiments on such a channel generally increases with increasing depth.

A natural river channel usually consists of alternating rifts and pools. At low-stream stages an appreciable portion of the total fall may be wasted at shoals, or there may be a part of the cross-section in deep pools and pockets in which little flow occurs and which is virtually ineffective. As the stream stage increases, these effects diminish. The coefficients of roughness deduced from experiments on such a channel generally decrease as the depth increases. (See *Engineering News*, Feb. 24, 1916, pp. 373-374, and April 29, 1915, p. 827.)

A channel with different degrees of roughness of the bottom and sides may be described as a channel with "composite" roughness. The value of Kutter's or Manning's n applicable to the sides of such a channel may be designated n_s, and that applicable to the bottom as n_b. The value of n derived from experiments on such a channel may be designated the "equivalent" roughness. If a channel had a degree of roughness corresponding to n throughout its entire cross-section, it would give the same discharge and velocity as the actual or experimental channel at the same depth and slope.

It is subsequently shown that a value of equivalent roughness derived from experiments on a given channel is really applicable only to a single depth; in other words, if the roughness of the bottom is not the same as that of the sides, the equivalent value of n varies with the depth. This is important because:

1. It helps to account for considerable difference in coefficients obtained experimentally on channels of apparently similar characteristics at different depths where the bottom roughness and side roughness are not the same.

2. While a single value of n can always be selected which will give correct results for a given depth in a channel with composite roughness, the use of a single value of n for different depths may lead to considerable error.

Hitherto there has not been available, so far as the author is aware, any rational method for determining the proper coefficients of roughness to be applied to a composite channel, even where the coefficients applicable to each of the components, *i.e.*, sides or bottom, are known. For example, values of n may be required which are applicable to a rectangular channel 20 ft. wide, for various depths, the bottom being of earth and stones with $n = 0.025$, and the sides of concrete with $n = 0.014$. Usually a value of n believed to be applicable to these conditions at average depths is selected by judgment. The formula subsequently given in this paper furnishes a definite answer to this problem for each depth.

Using Manning's formula and units of feet and seconds, let:

A = area of cross-section.
D = depth.
P = wetted perimeter, which for a symmetrical section is $B + 2L$.
B = bottom width.
L = side of section at depth D. For a rectanglar section, $L = D$
S = slope.
R = hydraulic radius.
v = mean velocity.
n_s = coefficient of roughness of the sides.
n_b = coefficient of roughness of the bottom.
n = apparent coefficient of roughness of the section as a whole computed in the usual way from observed values of v, D, B, L, A and R.

Then, since

$$v = \frac{1.486}{n} R^{2/3}\sqrt{S} \qquad (1)$$

$$n = \frac{1.486}{v} R^{2/3}\sqrt{S} \qquad (2)$$

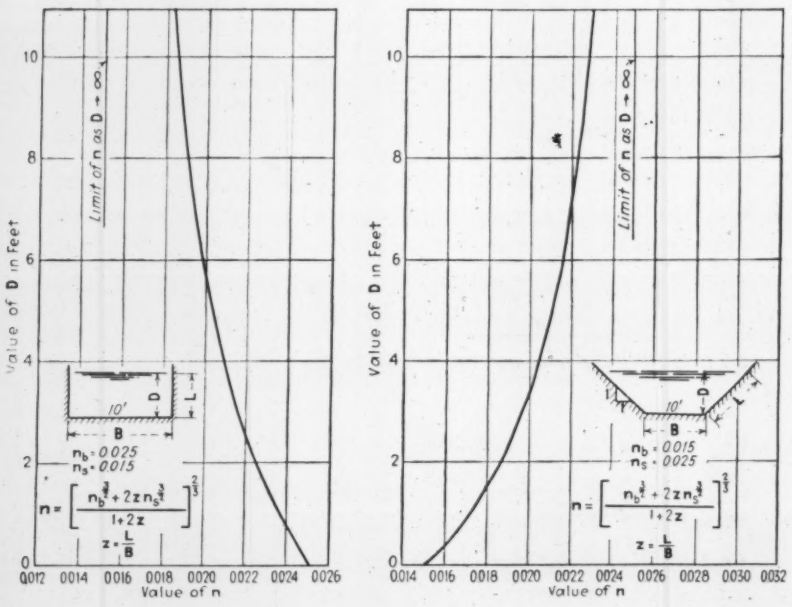
If n_s and n_b are unequal, the value of n thus obtained is not the true value of n for either the bed or sides, but is a value of n that would give the same velocity at the same depth and slope in a channel of the same dimensions with uniform roughness throughout. The values of n_s and n_b for a channel for which n is known for at least two depths may be derived as follows:

From Manning's formula

$$v = \frac{1.486}{n}\left(\frac{A}{B+2L}\right)^{2/3}\sqrt{S} \qquad (1)$$

Taking the reciprocal of this equation,

Fig. 1—Relation between D and n for rectangular and trapezoidal channel sections in which the bottom and sides have different roughness characteristics.



$$\left(\frac{1.486\sqrt{S}}{v}\right)^{3/2} = n^{3/2}\frac{B+2L}{A} = n^{3/2}\frac{B}{A} + n^{3/2}\frac{2L}{A} \quad (3)$$

This equation is correct using the equivalent roughness n, but the roughness applicable to the bottom is n_b and to the sides n_s, and there is some pair of values of these quantities which satisfies the left-hand member of Eq. (3). Inserting n_b and n_s and equating with Eq. (3),

$$n^{3/2}\frac{B}{A} + n^{3/2}\frac{2L}{A} = n_b^{3/2}\frac{B}{A} + n_s^{3/2}\frac{2L}{A} \quad (4)$$

Let $z = \frac{L}{B}$, and cancelling A,

$$n^{3/2}(B + 2zB) = n_b^{3/2}B + n_s^{3/2}2zB$$

or

$$n^{3/2}(1 + 2z) = n_b^{3/2} + 2zn_s^{3/2} \quad (5)$$

With two pairs of values of n and z:

$$n_2^{3/2}(1 + 2z_2) = n_b^{3/2} + 2z_2n_s^{3/2} \quad (6)$$

$$n_1^{3/2}(1 + 2z_1) = n_b^{3/2} + 2z_1n_s^{3/2} \quad (7)$$

$$n_2^{3/2}(1 + 2z_2) - n_1^{3/2}(1 + 2z_1) = 2n_s^{3/2}(z_2 - z_1)$$

and

$$n_s = \left[\frac{n_2^{3/2}(1 + 2z_2) - n_1^{3/2}(1 + 2z_1)}{2(z_2 - z_1)}\right]^{2/3} \quad (8)$$

Also, when n_s is given, from (7)

$$n_b = \left(n_1^{3/2}(1 + 2z_1) - 2z_1n_s^{3/2}\right)^{2/3} \quad (9)$$

The values of n_b and n_s can be determined directly from these equations.

In design, n_b and n_s may be given and n is required. From Eq. (5)

$$n = \left(\frac{n_b^{3/2} + 2zn_s^{3/2}}{1 + 2z}\right)^{2/3} \quad (10)$$

Since n_b and n_s are constant, it is evident that n will vary with z, i.e., with the depth. If $z = 0$, $n = n_b$; also n approaches n_s as z approaches infinity.

For example, $n_b = 0.025$, $n_s = 0.012$, in a rectanglar channel with $B = 10$.

For $D = 3.33$, i.e., $z = \frac{L}{B} = \frac{3.33}{10} = 0.333$

$$n = \left(\frac{0.025^{3/2} + 0.667 \times 0.012^{3/2}}{1.67}\right)^{2/3} = 0.002944^{2/3} = 0.0206.$$

The graph of formula (10) starts at $n = n_b$ for $z = 0$ and approaches the value $n = n_s$ asymptotically as the depth increases. This is illustrated by Fig. 1, which shows the variation in equivalent n with depth, for two channels. For the rectangular channel the bottom roughness is greater than that of the sides and n decreases as the depth increases. For the trapezoidal channel the side roughness is the greater, and the curve starts at $n = n_b = 0.015$, increasing with depth and approaching the limit $n_s = 0.025$. In both these cases serious error of results would follow if a constant value of n were used for all depths.

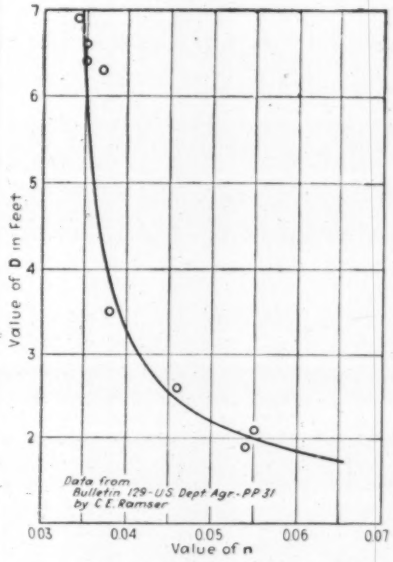


Fig. 2—Relation between D and n for the dredged channel of Sugar Creek, near Henderson, Tenn.

The forms of these curves suggest a graphical method of determining n_s and n_b. If the values of n derived from a series of experiments at various depths in the same channel are plotted in terms of D, as in Fig. 3, and a smooth curve is drawn through the plotted points, the intercept of this curve extended to intersect the x-axis will be n_b. Unfortunately, data adequate for the determinatjon of n_b and n_s by this graphical method are meager, and the values of these quantities must generally be computed by Eq. (8) and (9).

C. E. Ramser states ("Flow of Water in Drainage Channels," Tech. Bull. 129, U.S.D.A., November, 1929, p. 31) regarding the channel of Sugar Creek (Fig. 2) that the side slopes were increasingly smooth and regular as the height above the bottom increased, while the bototm was very rough and irregular, with numerous holes. Wanting data for depth below 2 ft. it is impossible to determine n_b graphically. The value of n_s is apparently in the vicinity of 0.030.

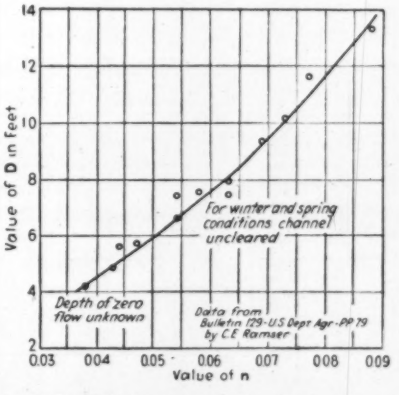

Value of D in Feet
Value of n
For winter and spring conditions channel uncleared
Depth of zero flow unknown
Data from Bulletin 129-U.S. Dept Agr-PP 79 by C.E. Ramser

Fig. 3—Relation between D and n for the special dredged channel of Lake Fork, Ill.

Fig. 3 shows a case where the roughness of the sides of the channel was greater than that of the bottom, owing to a dense growth of bushy willows, except near the bottom of the side slopes. In this case it is impracticable to determine n_b by extending the curve downward, as there was a silt bar across the channel, so that the velocity became zero for a depth greater than zero. With the differences noted, the curves shown on Figs. 2 and 3 have the same characteristics as the computed curves of Fig. 1.

The formulas given are based on the assumption that the effect of roughness in producing turbulence or resistance to flow is additive. At present there is no quantitative measure either of roughness or turbulence available other than the coefficient n. Much remains to be learned both as regards turbulent resistance and the relation of the character, amount and disposition of roughness of the perimeter of a channel to the amount of turbulence produced.

Experimental data indicate that up to a limiting point, not as yet defined, the effect of roughness appears to be an additive property; in other words, a surface containing ten distinctive rugosities of a given form and size, scattered at random, per square foot, would apparently have twice as large a value of n as a surface with five rugosities per square foot, of the same size and form and similarly disposed. It is, however, by no means certain that a surface with 1,000 rugosities per square foot would have 100 times as large a value of n as one with 10 per sq.ft.

In further explanation of the statement that the effect of roughness is here assumed to be additive, it may be noted that the effect of roughness quite certainly is not proportional to the volume of roughness, as has sometimes been assumed. What is here assumed is that it is proportional to the *density* or number of rugosities of a given form and volume per unit of area. It is certain that a single rugosity of 1-cu.in. volume per square foot will not have the same effect as 100 rugosities of 0.01-cu.in. volume each per square foot. It is not altogether certain that a composite surface, to one-half of which a value of $n = 0.015$ applies and for the other half of which $n = 0.025$, will have the same hydraulic properties as a surface with the same total number of rugosities of each of the two types, distributed over the entire surface, each with one-half its original density.

Subject to the limitations described as to the additive characteristics of rugosity, the formulas given are rational and are offered as a marked improvement over existing methods of determining values of n applicable to channels with two degrees of roughness.

Earthquake-Shock Transmission in Tall Buildings

Upward progression of shear deformation due to a single shock impulse and its successive reflections analyzed by simple approximate method

By H. M. Westergaard
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A SUDDEN horizontal earthquake shock under a tall building will cause a wave of deformations to travel through the building to the top. The wave will be reflected at the top, return to the foundation and be reflected again, and it may be reflected partly at intermediate elevations, so that several simultaneous waves are formed. The energy will be dissipated gradually by damping and by incomplete reflections. The safety of the building will depend on the stresses created in this mechanical action.

The whole building may be interpreted as a vertical beam, but it will be a beam of an unusual kind. An ordinary solid beam deflects, mainly due to the bending moments, and to a less extent due to the transverse shears. That is, it deflects mainly by shortening and lengthening of the fibers and to a less extent by sliding of the cross-sections relative to the adjacent ones. The building, regarded as a beam, has a coarse structure consisting of the columns and the horizontal beams. It deflects horizontally mainly by bending of the columns and the horizontal beams, and only to a small extent by changes of the lengths of the columns. Consequently the joints of columns and beams will move mainly by sliding in horizontal planes.

For the purpose of an approximate analysis one may, then, represent the building by an unusual solid beam, which deflects only by sliding of the cross-sections due to transverse shears and not at all by bending due to the bending moments. An approximate analysis obtained in this way will not apply when the shock is so exceedingly sudden that the stresses will rise and fall during the time that it would take a wave to travel through one or two stories. It appears, however, that the more significant shocks develop less suddenly, and then this analysis may be expected to throw light on the problem.

The dynamics of a beam deforming by shear only is simple. In fact, the equations of motion will have the same form as those of longitudinal sound waves transmitted through a solid rod or those of a water hammer. (See, for example, S. Timoshenko, "Vibration Problems in Engineering," 1928, p. 285).

Any horizontal translation of the ground may be resolved into two components parallel to the two sets of vertical frames. It will be sufficient to consider one of these components. The shock, then, is assumed to be in a horizontal direction parallel to one of the sets of frames. It will be assumed, furthermore, that there is sufficient symmetry in the distribution of mass and stiffness to eliminate tendencies of the building to twist about vertical axes. Thus, the case of a heavy eccentric tower is not considered here.

The ideal building

It is expedient to begin by considering an idealized case. In Fig. 1 the stiffness and weight are constant throughout the height of the building. Also, the loss of energy by damping and incomplete reflections of the waves will be left out of consideration.

The following notation is used:

t = time; x = vertical distance, positive upward; y = horizontal deflection, function of x and t, positive toward the right; S = sum of the horizontal shearing forces in a horizontal section through the columns at the elevation defined by x, positive toward the right when acting on the part below the section; K = stiffness defined as S divided by the average rate of increase of y between two successive floors; also defined by Eq. (1); w = weight of the building per unit of vertical distance; g = acceleration due to gravity; V = velocity of the wave of deformations; $u = t \pm \frac{x}{V}$; $f = f(u)$ = function of u; $f' = \frac{df}{du}$; h = height of the building; T = duration of the shock; T_1 = maximum period of free vibrations.

With the building represented by a single vertical solid beam, deforming by shear only, the horizontal deflection y and the total transverse shear S may be treated as smooth functions. Then the relation between shear S, stiffness K and slope $\frac{\delta y}{\delta x}$ may be written as

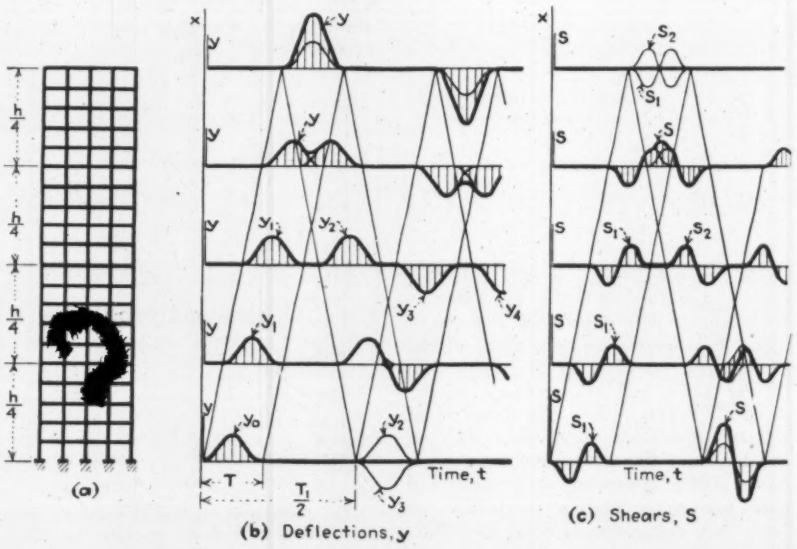
$$S = K\frac{\delta y}{\delta x} \qquad (1)$$

The part of the building lying between the elevations x and $x + dx$ will be acted upon at the bottom by a force S toward the left and at the top by a force $S + \frac{\delta S}{\delta x}dx$ toward the right. The mass of this part is $\frac{w}{g}dx$, and its acceleration toward the right is $\frac{\delta^2 y}{\delta t^2}$. The dynamic relation, force equals mass times acceleration, then takes the following form after division by dx:

$$\frac{\delta S}{\delta x} = \frac{w}{g}\frac{\delta^2 y}{\delta t^2} \qquad (2)$$

By substituting S from Eq. (1) we find that:

Fig. 1—Waves of horizontal deflections, y, and total horizontal shears, S, in a building with constant stiffness and weight throughout the height.


h/4
h/4
h/4
h/4
(a)
x
y
y
y

$$K\frac{\delta^2 y}{\delta x^2} = \frac{w}{g}\frac{\delta^2 y}{\delta t^2} \qquad (3)$$

and this equation governs the motion.

Eq. (3) is satisfied by a solution of the form,

$$y = f(u) = f\left(t \pm \frac{x}{V}\right) \qquad (4)$$

in which f is any function that can be differentiated twice, and in which

$$V = \sqrt{\frac{Kg}{w}} \qquad (5)$$

The correctness of this solution is verified by substitution in Eq. (3). Inspection of Eq. (4) shows that V is the velocity of the wave of deformations. The horizontal shear is found by Eq. (1) and (4) and is

$$S = \pm\frac{K}{V}f'\left(t \pm \frac{x}{V}\right) = \pm\sqrt{\frac{Kw}{g}}f'\left(t \pm \frac{x}{V}\right) \qquad (6)$$

Any number of waves represented by Eq. (4) and (6) may be combined by superposition.

In Fig. 1 the ground moves according to the curve y_0 shown at the bottom. After the time $t = T$, the ground is at rest. Let the equation of the curve y_0 be written as

$$y = y_0 = f(t) \qquad (7)$$

The movement creates a wave that travels upward, and which, according to Eq. (4), contributes the deflections,

$$y_1 = f\left(t - \frac{x}{V}\right) \qquad (8)$$

Curves representing y_1 are shown at b in Fig. 1 at different elevations. These curves lie within a belt which has a slope V relative to the axis of t. The corresponding shears,

$$S_1 = -\frac{K}{V}f'\left(t - \frac{x}{V}\right) \qquad (9)$$

are shown at c in Fig. 1.

When the wave y_1, S_1, reaches the top, a new wave, $y = y_2$, $S = S_2$, is created, which travels downward. Then y_2 and S_2 must be functions of $t + \frac{x}{V}$. Furthermore, it is required that $S_2 = -S_1$ at the top. These requirements are satisfied by the solution,

$$y_2 = f\left(t + \frac{x - 2h}{V}\right),$$

$$S_2 = \frac{K}{V}f'\left(t + \frac{x - 2h}{V}\right) \qquad (10)$$

Fig. 1 shows curves representing y_2 and S_2 and the combined values, $y = y_1 + y_2$ and $S = S_1 + S_2$, at different elevations. It is noted that $y = 2y_1$ at the top.

When the wave y_2, S_2, reaches the foundation, a new wave, $y = y_3$, $S = S_3$, is created. It is required that $y_2 + y_3 = 0$ at the foundation. We find that

$$y_3 = -f\left(t - \frac{x + 2h}{V}\right),$$

$$S_3 = \frac{K}{V}f'\left(t - \frac{x + 2h}{V}\right) \qquad (11)$$

Fig. 1 shows this reflection at the bottom, as well as one additional reflection at the top, creating the deflections y_4.

It is noted that the shears are doubled by the reflection at the foundation. In Fig. 1 a doubling of the maximum shear by combination of max. S_1 and max. S_2 also takes place at the elevation $x = 0.85\ h$. With a different duration of the shock, or with a different diagram y_0, addition of the maximum values of S_1 and S_2, with a corresponding tendency to destruction, may occur at any other intermediate elevation.

Attention is called to the dependence of the shears on the derivative f', that is, on the velocities of the ground during the shock. This dependence supports the suggestion (*ENR*, April 20, 1933, p. 504) that the intensity of earthquakes be measured by the maximum velocity of the ground, or by the maximum kinetic energy of the ground per unit of volume.

To vizualize the action represented in Fig. 1, we may imagine y and S laid off perpendicular to the plane of the drawing, whereby two surfaces are obtained. The zigzagging dikes and ditches formed by these surfaces represent the mechanical action.

Free vibrations and velocity of waves

Inspection of the diagrams of deflections in Fig. 1 shows that the maximum period of free vibrations, T_1, is four times the length of time that it takes the wave to travel through the height of the building; that is,

$$T_1 = \frac{4h}{V} = 4h\sqrt{\frac{w}{Kg}} \qquad (12)$$

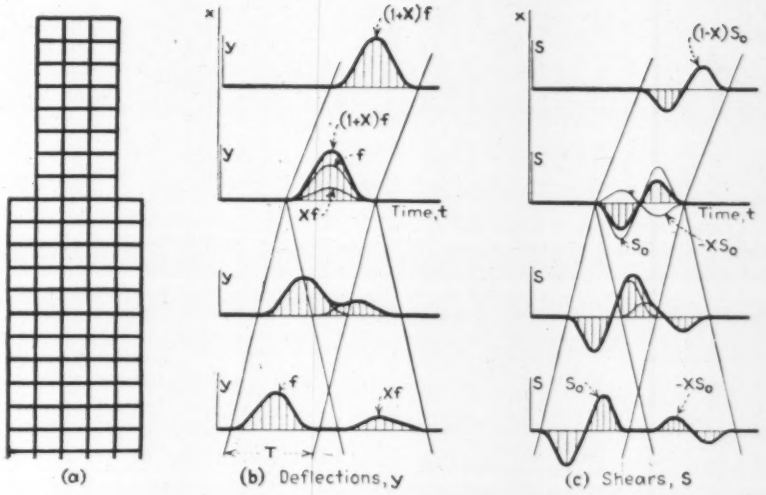


Fig. 2—Wave of deflections and horizontal shears partly reflected at elevation where the horizontal section of the building is reduced; the wave is transmitted upward with increased deflections and reduced shears; X = ratio of reflection of the deflections.

This conclusion is verified by the observation that with the ground at rest, Eq. (3) and the conditions at the top and the foundation will be satisfied by the solution,

$$y = y_{max}\sin\frac{2n\pi t}{T_1}\sin\frac{n\pi x}{2h};\ n = 1, 3, 5, \ldots \qquad (13)$$

when T_1 has the value given in Eq. (12). There are possibilities of observing T_1 in existing buildings, and thus one may compute values of V and $\frac{K}{w}$.

An idea of the order of magnitude of the velocity V may be obtained by examining a table of data for different buildings in Japan, published by Kyoji Suyehiro, in his "Engineering Seismology, Notes on American Lectures," (*Proceedings*, Am.Soc.C.E., May, 1932, Part 2, p. 75.) Case 1 (*a*) in this table will serve as an example. The particular steel-frame building has a height of 109 ft. above the street level. The height above the foundation may be estimated at $h = 121$ ft. The observed period of transverse vibration is $T_1 = 0.89$ sec. One finds then, $V = \frac{4h}{T_1} = 544$ ft. sec.$^{-1}$. In taller buildings the velocity V is expected to be somewhat greater.

Reflection at offsets

In Fig. 2 the vertical distance x is measured from the elevation at which the horizontal section of the building is reduced. The indices 1 and 2 will identify the quantities as belonging below or above this elevation, respectively.

A wave of deflections, $y = f\left(t - \frac{x}{V_1}\right)$, reaches the elevation $x = 0$, and is reflected in the ratio X and transmitted

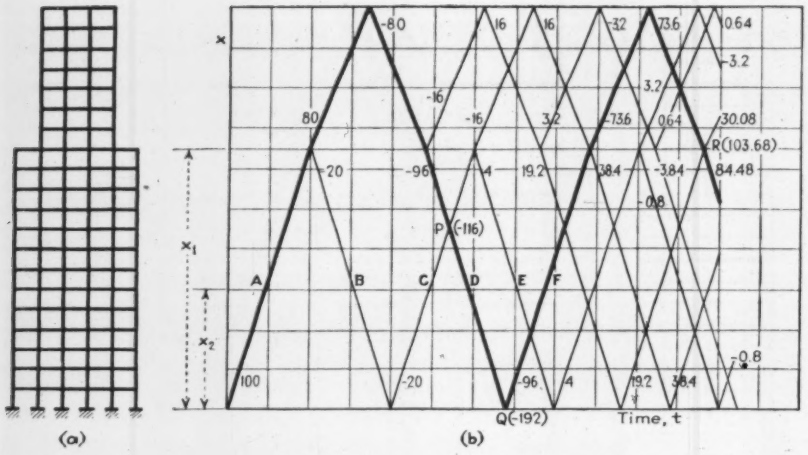


Fig. 3—System of reflected waves of horizontal shears. The lines define the beginning of each wave at each elevation. Beginnings of waves at the elevation x_2 are defined by points *A, B, C, D, E, F . . .* The numbers represent the intensities of the waves when the initial intensity is 100, and the ratio of reflection of the deflections at the elevation x_1 is $X = 0.2$. Combined intensities of waves intersecting at points *P, Q* and *R* are shown by numbers in parentheses. Damping is not considered.

in the ratio $1 + X$, so that the resultant deflections become:

$$\text{For } x < 0\text{: } y_1 = f\left(t - \frac{x}{V_1}\right) + X f\left(t + \frac{x}{V_1}\right) \quad (14)$$

$$\text{For } x > 0\text{: } y_2 = (1 + X) f\left(t - \frac{x}{V_2}\right) \quad (15)$$

Te corresponding shears are computed by Eq. (6). By equating the shears S_1 and S_2 at $x = 0$, we find that

$$(1 - X)\sqrt{k_1 w_1} = (1 + X)\sqrt{k_2 w_2} \quad (16)$$

which gives the ratio of reflection of the deflections,

$$X = \frac{\sqrt{k_1 w_1} - \sqrt{k_2 w_2}}{\sqrt{k_1 w_1} + \sqrt{k_2 w_2}} \quad (17)$$

The shears will be reflected in the ratio $-X$ and transmitted in the ratio $1 - X$, as indicated at *c* in Fig. 2.

Eq. (17) may be applied to a wave moving downward, except that the indices 1 and 2 must be interchanged. In this case the deflections will be reflected upward in the ratio $-X$ and transmitted downward in the ratio $1 - X$, and the shears will be reflected upward in the ratio X and transmitted downward in the ratio $1 + X$.

System of reflected waves

In the building in Fig. 3 waves are reflected at the elevation x_1, at the top, and at the foundation. In a short time a system of reflected waves is developed. It is expedient to represent this system of waves by drawing only the left edges of the belts in Fig. 1 and Fig. 2, and assigning a proper intensity to each wave. This has been done at *b* in Fig. 3. The intensities given by the numbers apply to the shears. The intensity of the original wave is called 100. An intensity —80 means the shears in the particular wave are —0.80 times those in the original wave. The assumed ratio of reflection of deflections at the elevation x_1 is $X = 0.2$. The increase of the number of lines toward the right indicates gradual spreading of the energy through the building. Fairly high intensities are found at the points *P, Q* and *R* by combining the intersecting waves.

Effect of damping

So far, damping has not been considered. The following approximate treatment is proposed. Each time the stresses change from the average to an extreme and back to the average, there is a loss of energy, which may be stated as a proportion of the energy represented by the rise or fall of the stress. The stresses continue to rise and fall because of the reflections of the waves. It is suggested, therefore, that the damping be summarized as a proportional loss in the intensity of each reflected wave. If in Fig. 3 there is a loss of 5 per cent in the intensity of each wave reflected at the elevation x_1 the first reflected wave will have the intensity —19 instead of —20. It is true that the three intensities 100, 80 and —19 are not consistent, but agreement would be established if the wave of intensity 100 could be assumed to have reduced to the intensity 99 on the way up from the foundation. There is little necessity for recording this insignificant change. If there is a loss of 5 per cent in the intensity of the waves reflected at the top, the intensity —80 of the first reflected wave should be changed to —76. At the foundation one should consider not only a loss due to repetition of stresses but also a loss by escape of energy back into the ground. Then the total loss of intensity at the foundation may perhaps be 10 per cent. And the wave that was reflected from the top with the intensity —76 instead of —80, and which is transmitted below the elevation x_1 with the intensity $-1.2 \cdot 76 = -91.2$ instead of —96, will be reflected at the foundation with the intensity $-0.9 \cdot 91.2 = -82.1$ instead of —96. This computation will account for a fairly rapid dying out of the vibrations.

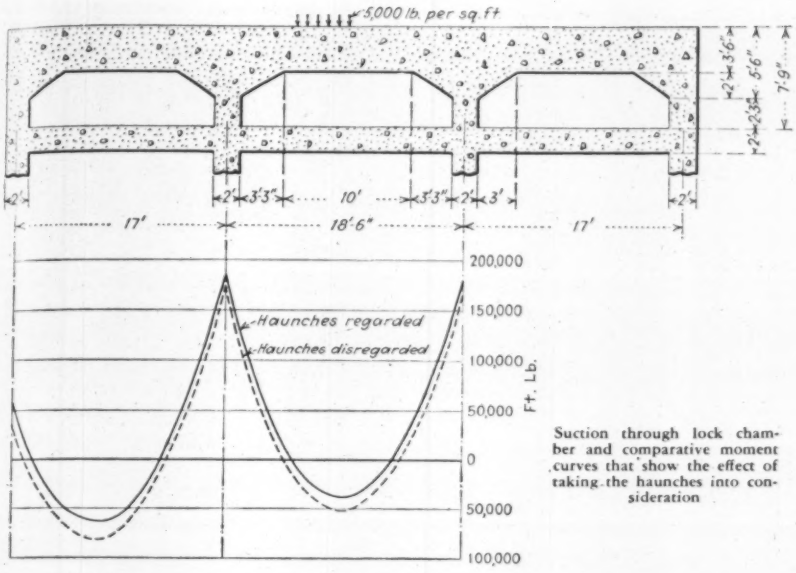
Effect of Haunches on Moments in a Concrete Slab

By B. M. Holman
Silver Spring, Maryland

IN CHECKING the design of an intake tower for a hydro plant the writer made a stress analysis for the lock chamber (shown in the sketch) that gave very interesting results both in regard to the validity of the moment coefficient method of design and the effect of haunches on distribution of moments.

MOMENTS OBTAINED BY THREE METHODS OF ANALYSIS

		End Spans			Center Span	
		Face of Outside Supp.	Center	Face of Inside Supp.	Face of Supports	Center
Effect of Haunches Taken into Account	M. in Ft.-Lb.	23,000	57,500	138,000	131,500	37,500
	Coefficient	$wl^2/49$	$wl^2/19.6$	$wl^2/8.2$	$wl^2/10$	$wl^2/36.3$
	%	100	100	100	100	100
Effect of Haunches Not Taken into Account	M. in Ft.-Lb.	0	75,000	128,000	122,500	52,000
	Coefficient		$wl^2/15$	$wl^2/8.8$	$wl^2/11.1$	$wl^2/26.2$
	%		130	93	93	139
Specifications	M. in Ft.-Lb.	46,900	112,500	112,500	114,800	114,800
	Coefficient	$wl^2/24$	$wl^2/10$	$wl^2/10$	$wl^2/12$	$wl^2/12$
	%	204	195	82	87	306



Suction through lock chamber and comparative moment curves that show the effect of taking the haunches into consideration

At a section where the load from saturated earth was assumed to be 5,000 lb. per sq.ft., three different sets of computations were carried out. In the first set a constant moment of inertia was assumed for the outside wall, while in the second the increase at supports was taken into account. In the third set the structure was analyzed as a series of arches on elastic piers. Moments, as computed by the second and the third method, agreed very closely and were used throughout in the work of revising the design.

By comparing these values with the original design, which was based on moments determined by standard coefficients, it was found that the $\frac{wl^2}{12}$ coefficient used for the center moment of the middle span was three times too high, and the $\frac{wl^2}{10}$ coefficient applied to the center of the end spans was two times too high; on the other hand, the negative moments at intermediate supports were 18 per cent too low, as shown in the table.

By arranging the reinforcing steel to conform to the final moments, several tons of steel were saved on this wall, and at the same time a more reliable structure was obtained.

The difference between the results of the first and second set of computations, which was entirely due to the haunches, was found to be 39 per cent at the center of the middle span, 30 per cent at the center of the end spans and 7 per cent at the face of the intermediate supports.

The first two analyses were carried out both analytically and graphically by the method of fixed points, while equations for the elastic-arch analyses were derived by the theory of elastic energy.

Swing Span of Bridge Is Built on Curve and Grade

By Henry W. Young
Portland, Ore.

DESIGN, layout and fabrication of the members for a new swing span over the John Day River on the Astoria-Svensen section of the Columbia River Highway in Oregon were complicated by curvature and gradient requirements. The bridge, of 118-ft. span, provides a 45-ft. clear channel on both sides of the center pier. It is located on a 4-deg. curve, calling for superelevation of the roadbed from $\frac{7}{16}$ in. on the inside of the curve to $4\frac{1}{16}$ in. on the outside. At the same time, the bridge is on a grade of $\frac{1}{4}$ of 1 per cent, so that the deck is slanted, tilted and curved.

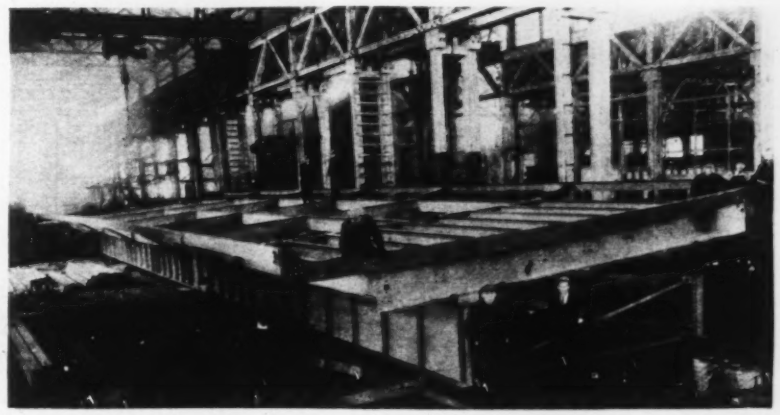
Main girders, 16 ft. apart, are 118 ft. long, and are parallel and level. On these are superimposed the seven floor beams, all set over at different distances from the center line of the bridge to account for the curvature. Superelevation of these floor beams was accomplished by a wedge under one end and a bracket of considerable height under the other. As far as the superelevation to secure the necessary banking effect is concerned, the angle is constant with all the floor beams. But due to the grade of the roadbed, the height of each floor beam above the girders is different from that of every other one. This resulted in a great deal of detail work in the design and fabrication of the members. The brackets vary from 1 ft. $2\frac{3}{4}$ in. to 1 ft. $5\frac{5}{8}$ in.

The deck is laid on 4x6-in. nailing strips on all of the fifty-four 15-in. 35-lb. I-beam stringers. This deck consists of 6x6-in. tongue-and-groove timbers, pressure-treated, topped by a 1-in. layer of surfacing materials. Approaches to the bridge are wood trestles with concrete decks.

Designers and constructors

The bridge was designed by the Oregon state highway commission—R. H. Baldock, state highway engineer; C. B. McCullough, bridge engineer; and O. A. Chase, designing engineer. Fabrication was by A. Young & Son, of Portland, for whom Sam Holmes is designing and shop engineer.

Assembling the swing span in the shop, showing the superelevation of the floor beams.



Extra Trusses Added to Indus River Bridge

Reconstruction of bridge in India for heavy rail loadings involves new 360-ft. trusses rolled into position complete, a new floor system and new cantilever vehicle roadways

By W. T. Everall
Deputy Chief Engineer Bridges, North Western Railway, Lahore, India

RECENT COMPLETION of the reconstruction of the Indus River Bridge on the North Western Railway, a hundred miles northeast of Karachi, India, enabled the structure to be opened to traffic at unrestricted speeds and marked the end of a program involving the strengthening of all the large bridges between Karachi and Peshawar. This section of the line is important as it forms the main connection between the Port of Karachi and the Punjab, Upper Sind and Baluchistan.

The reconstruction of the Indus River Bridge was begun at the end of 1930 to permit the running of the new standard heavy engines, which could not cross this bridge due to limitations in strength of the trusses and clearance infringements of the structure. In addition to strengthening the bridge, provision has been made for modern highway traffic, by building new cantilever roadways outside the main structure. Under the old conditions the road and railway traffic shared the same deck, which caused considerable inconvenience to the former in times of heavy rail traffic.

As may be seen from the accompanying illustrations, the bridge consists of five 360-ft. through spans of curved-chord Warren type and a 100-ft. pony approach span. To strengthen the bridge to take the heavier live loads and the additional dead load of the cantilevered roadways, extra main trusses of similar construction to those of the existing spans have been provided outside the existing ones. The existing railway floor has been replaced by a system designed to the new standard loading, and the old steelwork has been used to provide the vehicle roadway floor and its cantilever brackets on one side of the bridge. Electric arc-welding was used with success in the fabrication of the roadway cantilever brackets.

The new main trusses were so proportioned that, under the new dead and live loads with impact, they would relieve the existing trusses, in order to keep the maximum unit stress within the permissible stress per square inch both in the new and the existing work. This was achieved as follows:

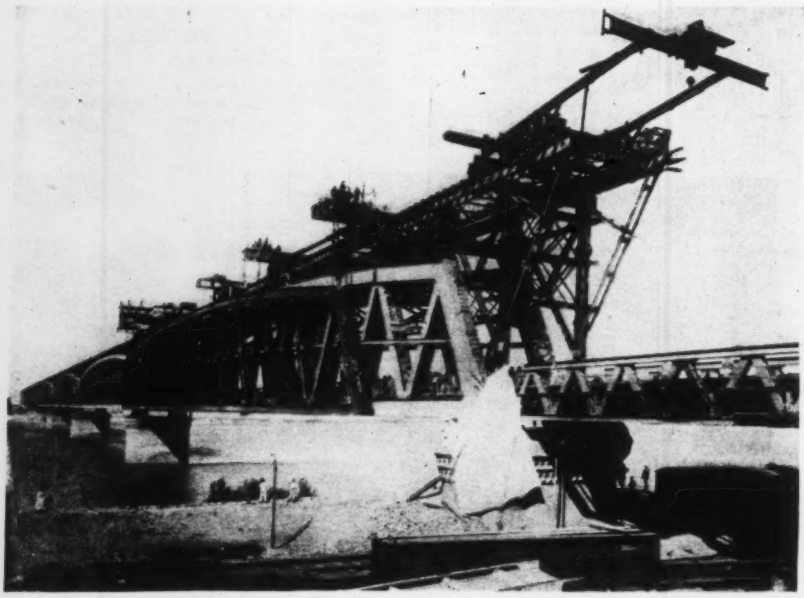


Fig. 1—Series of trolleys, electrically driven on a track on the top chords of the existing trusses, carries two 360-ft., 200-ton trusses in bridge-strengthening operation in India. After being placed, new trusses were connected by means of diaphragms to existing trusses.

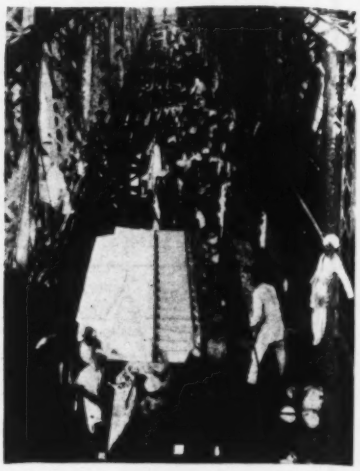


Fig. 2—Old roadway was replaced in 90-ft. sections, between trains.

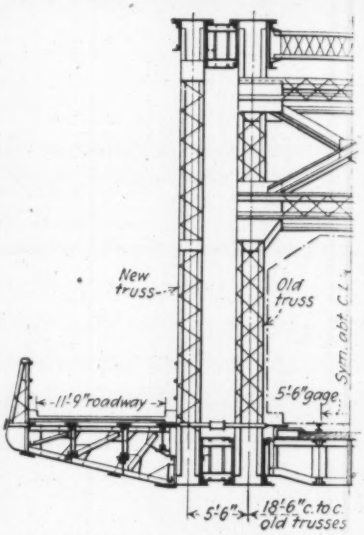


Fig. 3—Cross-section of Indus River Bridge, showing new trusses and new cantilever vehicular roadways. Railway floor system is also new, to accommodate modern locomotives.

After the new main trusses had been rolled into position and lowered on to their end bearings and before connecting to the existing structure, they were prestressed a calculated amount by means of calibrated hydraulic jacks placed between the new and the old work at each upper panel point. After this transference of dead load from the old to the new trusses, the connecting diaphragms at all intermediate panel points were riveted up before removal of the jacks. The new trusses of the 360-ft. spans have been fabricated in the special manner which has lately come into use in India as a means whereby the secondary stresses in chord and web members may be practically eliminated. This method involves the introduction during erection of reverse bending stresses in the members when in the fully cambered condition under no load. The Government of India Bridge Rules for 1932 permit an increase in the working stresses amounting to 12½ per cent when

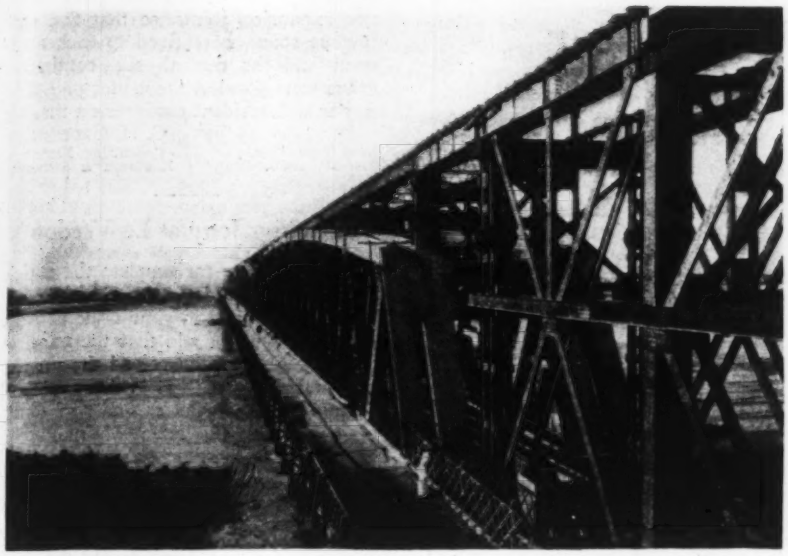


Fig. 4—Reconstructed Indus River Bridge, complete except for removal of overhead construction track.

proper steps are taken during erection to eliminate the secondary stresses.

An unusual and interesting feature in the reconstruction of the bridge was the method of erecting the 360-ft., 200-ton trusses. After being assembled at one end of the bridge, they were supported in pairs, one on each side of the bridge, on a series of trolleys running on temporary tracks erected on the top chords of the existing spans. One pair of the trolleys was equipped with an electric drive, and, using this means of propulsion, the trusses were moved to their respective positions in the bridge.

After all the new trusses had been rolled into position, the temporary tracks formed the road for a travelling electric overhead gantry crane, which was used to erect the new railway floor and the cantilevered roadways.

Fig. 2 shows the removal of the railway flooring, which was done in 90-ft. lengths during periods of 2½ to 3½ hours, when there was a lull in the traffic. Throughout the reconstruction there was little or no interference with either railway or road traffic.

The new trusses and flooring system were fabricated by Jessop & Co., Calcutta, from steel sections manufactured in the Tata Works at Jamshedpur under the inspection of the Indian Stores Department. The work is one of the largest of its kind manufactured by an engineering firm in India.

The preparation of the erection scheme and the execution of the work have all been carried out by the bridge branch of the North Western Railway.

The designs for the new structure were made by Rendel Palmer & Tritton, London, consulting engineers to the Indian State Railways, in collaboration with the writer.

Sewers Tested for Tightness by Measuring Outward Leakage

By H. R. F. Helland
Consulting Engineer, San Antonio, Texas

LEAKAGE tests were made on 63.9 miles of sanitary sewers constructed in Austin, Tex., during the years 1929, 1930 and 1931, under specifications requiring that leakage or infiltration into the sewers was not to exceed 20,000 gal. per mile of sewer per day. Although this allowable infiltration might in some respects be called large, at the same time it was an improvement in sanitary-sewer construction in that section of Texas. None of the bidders for the work had ever made any leakage tests or had been required to construct sewers with a specified tightness.

As groundwater rarely occurs in the area in which the sewers were constructed, the actual possible infiltration into the sewers could not be measured. For this reason the outward leakage was measured instead. At the upper end of the test section a 90-deg. bend was installed vertically; at the lower end of the section a 90-deg. bend and two joints of pipe were connected so that the lower stack would reach above the level of the upper bend. The sewer was then filled with water and allowed to stand for an hour in order to saturate the sewer joints thoroughly. When making the test the water level was brought to the top of the upper elbow, and this level was maintained for a certain period of time by the addition of water. With a known length of line, by measuring the amount of water added to maintain the proper level for a known period of time, the leakage per mile per day could be calculated. The maximum allowable head on the lower end of the pipe was 5 ft. On the larger sizes of pipe the same principle was employed, but bulkheads were used instead of elbows. Typical results of these tests follow:

Diameter, Inches	Leakage, Gal. Per Mile Per Day
15	3,870
15	19,800
30	12,000
8	4,750
8	14,900
6	2,200
6	9,500

Tests were made on lines and at locations determined by the engineer during construction. In receiving bids on the construction, the contractor was required to bid on making an estimated number of tests on the various sizes of lines included in his contract, covering the furnishing and installation of all equipment and furnishing of the water required for the test. Those tests that showed that the line being tested did not pass the specification requirements were not paid for. During the earlier part of the construction period the tests were made frequently, until the contractor became accustomed to doing work in a manner that would pass the requirements. During the latter part of the period it was found that practically every test would pass the requirements. Most of the excessive leakage was found due to carelessness in backfilling, the pipe being broken by rocks or the joints opened by the wedging action of fill material.

The method of making these tests was devised by C. G. Levander, sewer engineer, city of Austin. The writer was consulting and supervising engineer.

Irrigation in Spain

Spain plans a vast irrigation scheme to insure independence from agricultural imports, by deflecting the waters of the Tagus and Guadiana rivers to the Mediterranean coast lands (the Levante) that lack adequate rainfall, thus bringing 1½ million acres under cultivation. Dams and canals are to be built, if the proposals are accepted, to use water now flowing into the Atlantic. The best soil in Spain, suitable for growing maize, cotton and tobacco, is unwatered. These products comprise one-third the total imports, and all can be produced in Spain if water is available.

Letters to the Editor

Codes for City Governments?

Sir—It seems to me that there is a serious omission in the codes for various professional and industrial activites. It is apparent that for some time to come a large portion of the work of engineers and architects must come from state governments and cities and towns, and these governmental bodies do not operate under any code. The result is that the city fathers are in a position to pursue their usual chiseling tactics.

To express this in a more concise form, these bodies are in a position to insist that an architect or an engineer accept less than the rates heretofore established by various codes of ethics and probably less than rates to be established in the NRA codes. When employing an architect they may also refuse to pay separate compensation for engineering service.

All of which leads me to the question as to just why cities and towns should be exempt from any code. Is it a matter of law or is it merely an oversight? I believe that a little discussion among the various engineering oganizations might lead to the adoption of remedial measures.

JOSEPH F. WILBER,
Consulting Engineer.

Boston, Mass.,
Nov. 3, 1933.

Cumberland River Dam

Sir—The article by Major Besson in your issue of Oct. 5 on the new A-frame dam on the Cumberland River must have been of considerable interest to those engineers of the senior generation who, like the writer, were connected with the river improvements in the Ohio valley in the nineties. I had the privilege of assisting the late B. F. Thomas, the originator of the A-frame, in the details of his design, but the idea and the general design were entirely his work. He had studied movable dams and collected information about them to an extent probably greater than any engineer of his day, and had evolved a belief that an economical type of dam could be designed that would provide or remove the water barrier in one operation, instead of requiring a compound system of trestles with needles, wickets, etc., as had been the usual practice. A modern example of his theory is the rolling dam, which requires only lowering or raising in order to form or remove the dam. This type, however, is quite expensive, and the cost per foot run increases greatly with the span.

Mr. Thomas finally developed the A-frame dam (Fig. 2 of Major Besson's article) which has the remarkable property of allowing the units to stand touching each other when up, and to nest one inside the next when down. It combines with a maximum of simplicity and effectiveness the fundamentals of a movable dam.

After a considerable amount of evangelistic work Mr. Thomas was accorded permission to have the type tried out at Dam No. 6 on the Ohio, but he was enough of a river man to know that its location deep in a gravel bar would probably spell failure, as the first flood would restore the bar to its original outline and make it impossible to pull up the trestles. This happened, and, as Major Besson relates, the A-frame type unjustly went on the blacklist in consequence, and Mr. Thomas had to face a severe disappointment. He was given no opportunity during his lifetime for a further trial, but he never lost faith in the practicability of the type under suitable conditions, and it is therefore a genuine pleasure to learn that his efforts and his faith have at last been justified. With characteristic modesty he always refused to call it the Thomas dam, as he was urged to do, and gave it the more descriptive title of the A-frame dam.

American engineers have brought two noteworthy and original designs into the domain of movable dams—one, the bear-trap, now a hundred years old and still in successful performance; and the other, the simpler and more economical A-frame of B. F. Thomas.

DAVID A. WATT.

St. Petersburg, Fla.,
Oct. 23, 1933.

Multiple-Span Continuous Girders

Sir—In the article on "Economy Through Continuity in Girder-Beam Bridges" (*ENR*, Oct. 26, 1933, p. 496), the author suggests that since little reduction in girder weight can be obtained by the use of more than three spans in continuous series, and since greater length increases the difficulty of providing for thermal changes, three-span continuous groups are desirable in multiple-span bridges of this type.

As a matter of fact, expansion of a five-span continuous series of 70-ft. girders can be taken care of easily with an expansion joint and rockers of the same character as those shown. In a long bridge the saving in expansion joints by employing the longer continuous groups is considerable; also from the standpoint of the better riding qualities, a minimum of expansion joints should be used. A bridge of sixteen 70-ft. spans of 36-in. beams, and very similar in detail to the bridge shown in the article, was built in 1931-'32 at Bucksport, Me., over the east channel of the Penobscot River. It was built with two expansion joints, so that five continuous spans were fixed to each abutment and the central six continuous spans were fixed at the center pier. The writer was resident engineer on the job.

C. H. GRONQUIST,
Consulting Engineers,
Robinson & Steinman.

New York City,
Oct. 30, 1933.

Landing Jetty at Le Verdon

Sir—In order to complete the article on the landing jetty at Le Verdon, France, published in your issue of Aug. 31, p. 249, may I add that the name of the engineer who conceived the process of sinking caissons is Mr. Albert Caquot? He is chief engineer of Ponts et Chaussées, designer of numerous works in reinforced concrete and a notable inventor in aeronautics. At the same time he is a consulting engineer in civil engineering, professor of reinforced concrete at L'Ecole des Ponts et Chaussées, Paris, and technical director-general of the Ministry of Air, Paris.

LOUIS RAVIER,
Senior Principal Engineer
of Maritime Engineering.

Paris, France,
October 19, 1933.

Making the Highway Pay

Sir—Regarding the letter by Mr. Catton (*ENR*, Aug. 13, 1933, p. 177), commenting on the article of the writer, which appeared in your issue of May 11, 1932, p. 590, it was of course not intended to imply therein that operating costs are not a component part of total costs for highway as well as for any other transportation system. Emphasis was placed on the matter of selection of type according to revenues, for the reason that operating costs, due to surface characteristics, vary only according to road smoothness which in modern *well-designed* highways is practically the same, regardless of surfacing material used.

A review of the railroads' history will show that their early aims were much akin to those of the modern highways, viz.; to connect the several population centers at the earliest possible moment with a serviceable line. Almost immediately after the first railroad was in operation it became apparent that material economies could be obtained through better alignment and reduction of grade; but because of the lack of funds, and because then as now only approximate estimates could be made as to future conditions, such improvements were actually limited to come within the funds readily obtainable. A review of railroad history further develops the fact that all too often improvements made on the basis of these estimates proved to have been made either too soon or to have been so much in error on future conditions as to have brought on many instances of bankruptcy.

Highways, in their construction and maintenance, while akin to railroads in

fundamental principles, have one very great difference: while one agency builds and maintains the highways, another operates the vehicles over them, and it will never be possible to control this latter group in anything like the same way that is possible with railroads where both construction and operation are under the same authority. *More waste in operation costs on highways is due to the faulty handling of the vehicle than to faulty highway construction.*

Many of the studies that have been made on highways with regard to total cost of highway transportation have been made by men who, while unquestionably competent engineers, yet often have not had long administrative and executive experience in the actual construction and maintenance of public works. After twenty years of such experience one learns that political and social considerations modify the administration of a highway program in a way that is totally absent from private operations. By such a statement is not meant necessarily the inference of anything wrong in the term "political," but rather that the inherent nature of legislative action both collectively and as represented by individual officials has a weight far greater than can be appreciated by one who has not had long experience as a part of the governmental structure. This condition has led in many cases to the layout of systems based on what appeared to be a sound policy but which subsequently proved to have been predicated on totally wrong conceptions.

It is to be seriously doubted whether anyone is intelligent enough accurately to picture the conditions in the transportation industry of this country twenty years hence. It is with this thought in mind that a program of *building of roads for the traffic that now uses them* is essentially sound in principle, and that with reasonable allowance for expected growth (as provided by stage construction) and with attention to the fundamental layout as regards grade and alignment it will permit the most economic use of public funds in keeping the surface equal to traffic needs.

The cost of operation over a highway, so far as the physical limitations of the road itself are concerned, is affected by grade, alignment and character of surface. Alignment is far more important than grade in highway work because of the greater flexibility of the vehicle that uses the road. If alignment is proper, grades can always be modified, while increased capacity can be provided by widening. With regard to cost of operation as affected by character of surface, the important consideration is smoothness; and experience has fully demonstrated that so long as a road surface is smooth it makes very little difference whether it is made out of asphalt, concrete, brick or earth, provided that it stays in a permanently smooth condition. Obviously, any of the standard types of surfacing, such as asphalt, tar, concrete and block pavements, can be constructed and maintained in this smooth condition when designed in accordance with traffic. The point that the writer has been endeavoring to make for years is that there is no one single type of road which most economically meets all situations; the article referred to pointed out this difference in type of surface requirement and the fact that a suitable road with the lowest possible total operating cost can be built within the funds available from current taxation. The crying need of today is, first, to evaluate traffic flow and then to place a type of improvement that will take care of such traffic. This should be effected without placing unnecessary burdens upon future generations and without stretching the imagination as to hoped-for savings in order to justify the placing of a pavement that is unnecessarily expensive regardless of its composition.

BERNARD E. GRAY,
Highway Engineer,
Asphalt Institute.

New York, N. Y.,
Oct. 30, 1933.

Old Cornish Pumps at Jersey City Waterworks

Sir—The "Water Supply Progress" number of *Engineering News-Record*, June 8, 1933, contains an article written by Theodore A. Leisen on the development of pumping machinery, in which mention is made of the Cornish pumps installed at Louisville, Ky., in 1860. Reference to these pumps suggested that your readers might be interested in the accompanying photograph of the old Jersey City Waterworks, located at North Arlington, N. J., on the Passaic River. The plant has been abandoned for many years and, although somewhat damaged by fire and vandals, it has stood in a good state of preservation until a few months ago, when demolition operations began. The inscription on the tablet in the pump room reads:

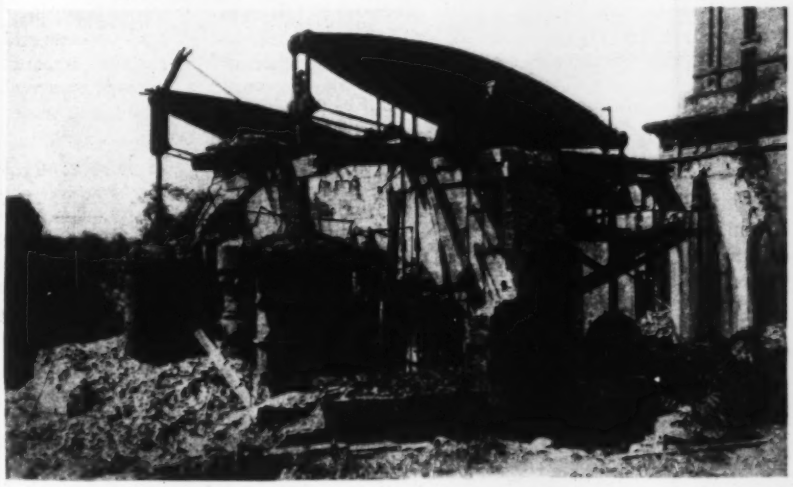
Jersey City Water Works
Cornish Pumping Engine
Built by
William Birkbeck
Fulton Foundry Jersey City
A.D. 1862

Originally there were three of these pumping engines, but one had already been demolished at the time that the photograph was taken. The pumps were housed in a brick building which, with its buttressed walls, closely resembled a church. The high water tower adjacent was built in a corresponding style of architecture.

FREDERICK M. WEISS.

Passaic, N. J.

Old Cornish pumping engine at abandoned Jersey City waterworks.



Credit to Mr. Henny

Sir—In the article published in your edition of Oct. 26, 1933, entitled "Metal Faced Gravel Dam Being Built in New Mexico," I failed to mention that D. C. Henny of Portland, Ore., was acting as consultant on this work. Mr. Henny deserves most of the credit for the designs adopted and also for ironing out the difficult problems that came up in this work.

H. P. BUNGER,
Designer, Middle Rio Grande Conservancy District.

Albuquerque, N. M.,
Nov. 10, 1933.

Exit Practices in Buildings

Sir—With reference to the exit movements of crowds, as discussed in your issues of Aug. 10 and 17 and Oct. 12, pp. 164, 200 and 449, it might be useful to consider the observations of crowd movements at railway stations. These are given in some detail in a report of the yards and terminals committee published in the *Proceedings* of the American Railway Engineering Association a few years ago.

E. E. R. TRATMAN,
Civil Engineer.

Wheaton, Ill.

Engineering News-Record

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Code Progress

DISPUTED points in the basic code for the construction industry still are under discussion by the committee appointed by the National Recovery Administration following the hearing on Nov. 20. It is reported that progress is being made, although the reconvened hearing, scheduled for Nov 27, has been put off until Dec. 4. Meanwhile there is reason to believe that the NRA still is convinced that unification of the industry under one code is desirable, despite the strong opposition of organized labor. The final form of the code may be modified considerably to conform with a uniform code now being drafted by Donald Richberg, chief counsel for the PWA, as that new form of code is expected to be ready almost any day. The engineers' code, which two weeks ago was thought to be in final form for approval as soon as the basic code was approved, has run into a snag in the form of united opposition from the large engineer-constructor firms such as Stone & Webster, U.G.I., and Rust Engineering Co., who are opposed to charging a separate fee for engineering services. As the point at issue is fundamental to the whole code—being considered as a form of unfair competition by men who do only consulting engineering work—it may hold up the code for some time.

The Itching Palm

ONE OF THE regrettable features of the CWA conferences in Washington was manifestation of a pork-barrel appetite by some local delegates. One suggested that CWA money ought to be used to build state institutions. Another wanted back-dues to unions paid from the fund. And a Western Congressman unflinchingly urged the interesting plan of donating a few hundred dollars to every householder for repairing his house. When one thinks of such sentiments, expressed in open meeting, and couples with them the effort of some PWA applicants to get 100 per cent federal grants for projects of essentially local character and the withdrawal of some loan applications when the applicants became convinced that the loan would have to be repaid, it becomes apparent that there are a good many local officials who like to get something for nothing and who are unwilling to do their part in the job-making campaign. Leeches will always be with us, of course, but fortunately they are a very small minority. At present it does not seem likely that the parasite spirit should reach over into the deliberations of the new Congress, next month, and cause a public-works-gift plan to be proposed. Most people understand that all the expenditures must be repaid in due course, and that shifting a debt from the local to the national budget still leaves the debt resting on the same shoulders. And most communities and their officials realize that they have a definite responsibility toward the public-works re-employment campaign, and that it is necessary to join hands all round in order to overcome the paralysis of idleness.

Filters for Chicago

AS A RESULT of city council authorization, Chicago is in a position to apply for PWA funds to build a water-filtration plant for the south third of the city. Because of the practically undrinkable, non-palatable character of the water in this district, nothing of a public-works nature in Chicago is more needed. For the same reason no security is safer than the self-liquidating water certificates that the city can pledge for the loan. Findings at a testing station maintained for several years have been analyzed and converted into plans sufficiently developed to permit close cost estimates. Chicago has a vast army of unemployed that would benefit from the construction of a large filtration plant and the necessary appurtenances. But regardless of unemployment needs, the project should be undertaken at once entirely on its own merits.

Cut Some Red Tape

A RECENT statement by the Public Works Administration reveals that it is receiving applications for loans for non-federal public works projects at the rate of 300 a week. The PWA, however, is approving less than 100 a week and has piled up in the neighborhood of 1,500 pending applications. This raises the question as to whether the legal department is holding up sound applications by needless red tape or whether the delay is due entirely to lack of staff. If red tape is the cause, it should be cut by Administrator Ickes; if staff is lacking, plenty of men are available to expand it. Inquiry among applicants for loans makes it very clear that many applications which might logically be expected to go through in a few days have been held up for weeks. This not only is delaying a lot of needed work but also is causing a great deal of inconvenience to the towns that have made the applications in good faith; in some towns it is raising financial difficulties. Such a condition should not be allowed to continue. Strict limitations were set up by Secretary Ickes in a commendable effort to keep the public-works section of the Recovery Act from being converted into a pork-barrel; but if his legal advisers have developed his limitations to the point where they hold up worth-while projects, he should modify the restrictions sufficiently to permit such projects to get prompt approval. He can do this under the broad powers given him under the Recovery Act.

A Word of Caution

THERE is being circulated among engineers a letter from the Federation of Architects, Engineers, Chemists and Technicians seeking signatures to two declarations, one stating that the signer has never assented to the code of fair competition for the professional engineers' division of the construction industry and expressing disapproval of the wage and hour provisions contained therein; and the other, authorizing the federation to represent the signer in matters of NRA codes. The federation's letter is so full of untrue and misleading statements as to call for a word of caution to those who

may be led to sign one or both of the declarations accompanying it. It is not necessary here to attempt to refute statements made in that letter. To those members of the American Society of Civil Engineers who have received the letter (for apparently one of its principal objects is to obtain signatures from within that organization) we recommend that they check the statements concerning the provisions of the code with the code itself and with the explanatory statement as published in the November issue of *Civil Engineering;* also that they reflect upon the fact that the charges of bad faith, so lightly made, and directed at the men, well known in the profession, who have labored to prepare a code that would be fair alike to employer and employee, are made by men unknown and with one exception unnamed, who seek to have themselves appointed to represent the employed engineer in code matters. To date, the record of the federation is not one to inspire confidence in its ability to represent anyone in code negotiations.

The Long View

IN A RECENT ISSUE of an engineering society journal of the Northwest there appears a dissertation on dwindling natural resources in the district and the consequent flattening out in the curve of population increase. The writer, Professor R. L. Ryerson, of the University of Minnesota, points out that the rural population of the state is already stationary and that the increase in urban population is fast slowing down. Because Minnesota has not kept pace industrially with the average of the United States, she lost 70,000 persons by migration in the 1920-'30 decade, he writes.

What is to be done about it? Recognizing the trends as significant, public-spirited business leaders have organized the Northwest Research Foundation to finance researches looking toward the development of new industries as well as stabilization of those already existing.

Basic raw materials being in abundance in the Northwest, it is hoped that research may develop new industries to take the place of those that are declining. Lignite may be used to produce fixed nitrogen for fertilizer. Second-growth aspen of no use now might produce a high-grade alpha cellulose from which the rapidly increasing volume of rayon is derived, thus replacing the dying lumber industry. Some additional commercial uses may be discovered for the millions of bushels of low-grade grains that come to market. At the Iowa State College the chemical engineering department in cooperation with U. S. Department of Agriculture chemists has been conducting researches with waste agricultural products for the past two years. Of the twenty materials investigated it has been found that alcohol can be made from corn and beets, a substitute for cork from sugar cane, motor fuel from oat hulls, wood substitutes from cornstalks and a water-supply purifier from pecan shells.

But why picture all this to the engineer? The *Bulletin* of the Minnesota Federation of Architectural and Engineering Societies and Professor Ryerson made no apologies, nor did the editor offer any, for taking up space that might have been devoted to hydraulics or structural details. And they should not, for it is daily becoming more obvious that the engineer must take the long view, and evaluate his particular projects against the general economics of a region. If power use is waning, how can he hope to build more hydro-electric plants? If the farmer population is stationary or declining, there is a limit to the extension of highways. If the urban population is not expanding, decentralization is nearing an end, and decentralization has required water, light, electricity and transportation in large quantities. Only by taking economic trends into account can the engineer of today hope to cope with mankind's needs of tomorrow.

A Job To Do

CONTRACTING, in common with other businesses, is entering an era of code government. Like other businesses it must organize to meet its new responsibility of self-government under code authority. For a decade and a half the business has been represented by the Associated General Contractors as a recognized national body. Today this organization is the only one that can claim to represent contractors and the contracting business as a countrywide institution. To it, therefore, the great business of building must look for initiative and leadership, or contracting must create a new trade association that can measure up to the new organizational task.

The situation confronting the Associated General Contractors presents an opportunity and a crisis. If it is to be met effectively, immediate mobilization and prompt action are desirable. The need for organization is plain. With code government the contracting business loses a great part of its old caste classifications. With the same wages, work hours, working conditions, credit practices, prices and business procedures, a commonalty of contracting conditions will be created that previously existed only in the availability to all of the same materials, equipment and technical knowledge. Possessions, skill, business initiative and acumen afford the only remaining distinctions between contractors. Code creation has made contracting a democracy. It now remains for contracting to make of itself a federated democracy.

The activities and controls of the new code government of contracting will affect the entire industry, from the great organizations that create the construction monuments of the world to the small carpenter or mason builder. This is a fact that organized contracting must recognize if it is to represent the contracting business as organized labor represents the construction workman. At present the organization of contracting is fragmentary, but it nevertheless is the logical nucleus about which, with true vision and leadership, a close-knit and efficient federation can be created. The leaders and privates in the Associated General Contractors of America have this important task to perform. It should be the immediate labor of the few weeks that precede the coming annual association meeting to plan the new organizational structure.

A centrally initiated and directed plan is essential to an autonomous hard-hitting organization. Local chapter multiplication and expansion of membership will not meet the need unless they head up in a logical plan for coverage, statistical and economic service, legislative activity and coordinated administration. Without such development, the organization of the contracting business will remain as it is now—partial, scattered and without the mobilized force that it needs to exert its rightful power in a code-governed construction industry.

NEWS OF THE WEEK

Construction Code Hearing Postponed For Committee Report

HEARINGS on the code for the construction industry, adjourned on Nov. 20 to reconvene on Nov. 27, have been postponed to Dec. 4 pending a report by the committee named by the Administrator following the hearing on Nov. 20. The reconvened hearing is to be held in the auditorium of the U. S. Chamber of Commerce, Washington, D. C. It is expected now that the hearing may again be postponed as the committee may not be ready to report by Dec. 4.

Since the personnel of the committee representing the National Recovery Administration, the American Federation of Labor, the Construction League of the United States, the Associated General Contractors of America and the subcontracting group, was published in our issue of Nov. 23 (page 635), the committee has been expanded by adding Oscar Rosenthal of Chicago and W. P. Carroll of Cleveland to represent the Building Trades Employers Association. This committee was appointed in an effort to work out and agree upon disputed points and to report back to a reconvened hearing.

Revised code considered

Following a meeting of the committee on Nov. 24, Assistant Administrator R. W. Lea and General Counsel D. R. Richberg made the following announcement:

"At a meeting of the Conference Committee on the Construction Code this morning a revised code, drafted by the NRA representatives, was presented to the committee and extensively discussed. No agreement on the code was reached, but without committing any member of the committee, it was agreed that the members of the committee would submit the tentative code to the groups respectively represented by them for their consideration and any suggestions of further revision, and would report back to a meeting of the conference committee, which has been set for 11 a.m., Monday, Dec. 4.

"It was found impractical to arrange for an earlier meeting because of the Thanksgiving holiday period of next week. The representatives of the NRA feel that most encouraging progress has been made toward the drafting of a code which may be satisfactory to all interested groups. We desire to emphasize, however, that no member of the committee has committed himself individually, or in behalf of his group, to an approval of the tentative code as a whole, or the specific provisions therein."

The engineers' code, which was thought to be in shape for approval by the President as soon as the basic code was approved, may now be delayed due to organized opposition from the large engineer-constructor organizations who object to making a separate charge for engineering services.

Planning Work To Be Expanded Under New PWA Allotment

An allotment of $250,000 to the National Planning Board from the Public Works Administration, following closely upon the announcement about a week ago of an allotment of $35,000 to the board, has been made by the PWA in order to stimulate the preparation of state, regional, local and city plans. The program of the National Planning Board contemplates the sending of qualified technical advisers to such district, state, city and regional planning units as meet with the requirements of standards set up by the board. These advisers will stress the need of practical planning and will endeavor to coordinate efforts in this direction which may be made in any community. Their work will be chiefly of an educational nature.

It is also contemplated that upon the organization of new planning units throughout the country, which in the opinion of the National Planning Board and the Public Works Administration, have the assurance of local support, one or more technical experts will be appointed to organize and direct the work.

The allotment of $35,000 to the board was made to permit it to ascertain the extent to which planning researches and surveys are now being made throughout the country and to study and correlate these studies. The data to be collected will cover such subjects as natural resources, population distribution and trends, problems of health, local planning, and researches having a bearing on national welfare.

Bid of $790,000 Submitted For Trestle Over Spillway

A bid of $790,000 has been submitted by the Kelleher Construction Co., Dallas, Texas, for the construction of a highway trestle over the Bonnet Carré spillway above New Orleans. Bids were opened on Nov. 21. The Gifford-Hill Construction Co., Dallas, submitted a low bid of $312,000 for the construction of the earth embankments serving as approaches to the bridge. The combined offers are stated to be within the funds available for the work.

No announcement has been made as to agreement over the railroad bridges across the spillway, but it is now believed that three railroad bridges are to be built. Discussion of these bridges was under way in Washington last week but no official announcement has been made as to any agreement.

CWA Sees Four Million Unemployed Men on Its Payroll by December 7

HARRY L. HOPKINS, Civil Works Administrator, is confident that by Dec. 7, the entire 4,000,000 unemployed men that his program embraces will have been transferred to civil works payrolls. State and local funds have been pledged in considerable amount, according to Mr. Hopkins, and anxiety that there would be an insufficient number of projects to provide employment has been supplanted by embarrassment due to the large number that local civil works divisions are ready to undertake.

Federal projects readied by the Forest Service, Bureau of Entomology, Bureau of Plant Industry, Bureau of Animal Industry and Bureau of Chemistry and Soils of the Department of Agriculture will give employment to 69,801 men. The Soil Erosion Service, Bureau of Indian Affairs and the District of Columbia Park division of the Interior Department have taken 5,736 men to date. The Coast & Geodetic Survey of the Commerce Dept. has mapped out a program for 15,030 men. The Public Health Service of the Treasury Department will put 30,000 men on rural sanitation and a like number on malaria control. The U. S. Reemployment Service is absorbing 12,530 men and women in clerical and research jobs, and the Army will put 25,000 men to work on minor projects at its posts, camps and stations.

The total of 188,097 assigned to federal projects to Nov. 25 is small compared with the number that is finding employment on local projects. Mr. Hopkins is not yet willing to hazard an estimate but reports received to date indicate that the campaign will succeed within the time limit assumed.

Assignment of 12,200 men to the National Park Service, 696 to the Weather Bureau and 590 to Bureau of Entomology, announced on Nov. 27, brings total assigned to federal projects by the Civil Works Administration to 201,483.

The Public Works Administration has referred 87 projects that examination disclosed as more suitable for execution by the Civil Works Administration. Eighty of these were immediately forwarded by Mr. Hopkins to the appropriate state civil works administrators who, in turn will notify the various local administrations that they are eligible for inclusion in their work programs. About as many more PWA projects are still to be referred to CWA, according to Mr. Hopkins. Projects that CWA regards as beyond the scope of its work will be weeded out in Washington. It has been announced that all civil works employees are covered by workmen's compensation.

An announcement by Eugene L. Vidal, director of Aeronautics of the Commerce Department, that the Civil Works Administration has set aside $10,000,000 for the development of 2,000 airports and landing fields throughout the country was refuted by Mr. Hopkins. Local airport projects are eligible for inclusion in the civil works program but the extent of such work will depend on the initiative of the communities.

Three San Francisco Schools Closed as Earthquake Hazards

Three public schools in San Francisco were declared a menace to occupants in case of earthquake in a recent report of a board of consulting engineers and were immediately ordered closed by the school board. Reconditioning will be undertaken at once to meet the requirements of the new California law and the recommendations of the consulting board.

The board, composed of Earle L. Cope, H. J. Brunnier, Walter L. Huber and L. H. Nishkian, local consulting structural engineers, was requested to report on the condition of the structures and outline necessary provisions to render them safe. Of the four schools covered in the study, three were condemned as to occupancy, and the auditorium of the fourth was found unfit for use.

Conditions found to exist in the structures, varying from ten to twenty years old, were not materially different from those brought to light by the earthquake in Long Beach, which was a direct factor in instituting the present investigation. The San Francisco schools were found to have tons of insecure parapets and architectural treatments which had not been designed to resist lateral forces. In addition, the inadequate support of these elements had been weakened by serious deterioration in the ties and wires provided to hold them in position. Masonry walls were found to be inadequate and in many cases the vertical joints between courses of brick were entirely lacking in mortar. The lateral stability of these bearing walls was entirely inadequate. Conditions indicated not only improper design for earthquake resistance but also poor construction and inspection.

The report, after pointing out these deficiencies and noting the lesson recently demonstrated at Long Beach, condemned the buildings for further use in their present condition in plain, unequivocal terms which were intended for non-technical readers. Accepting the verdict of the consulting board, the San Francisco school board ordered the buildings closed until properly rehabilitated. As a result of this first report on four schools, an investigation and report has been ordered on four more.

One-Third of Road Projects Under Contract on November 18

Thirty-five per cent of the $400,000,000 road allotment to the states was under contract or was scheduled to be done by force account by Nov. 18. Contracts have been awarded or force account work started on 3,007 projects involving an estimated total expenditure of $153,772,000, of which $143,019,000 is PWA money. The balance represents state funds expended for right-of-way, etc.

In addition to projects now under contract, 996 projects have been advertised for contract, totaling $49,253,000, of which $44,812,000 is PWA money. Actually under construction on Nov. 18 were 1,767 contracts, totaling $107,952,000 and 474 force account projects, totaling $10,043,000. Fifteen projects have been completed totaling $248,000 as of Nov. 21.

Road projects totaling 4,250 have been approved by district engineers, involving an expenditure of $237,375,000, including the 3,245 projects on which contracts have been awarded.

CWA, Coast and Geodetic Survey To Cooperate on Survey Work

The CWA, in cooperation with the Coast and Geodetic Survey, is undertaking a large surveying program, consisting of triangulation, traverse, and leveling. The work, apparently, is to be distributed equally among the forty-eight states, the Coast and Geodetic Survey to have charge of the entire project through appointed state supervisors. Four hundred twenty men in each state are to be selected by the Coast and Geodetic representative from lists of available persons furnished by the local Civil Works Administration, the probable breakdown of these figures being: 11 engineers at $30 per week; 120 second engineers at $28 per week, and 289 others at $12 to $25 per week. All expenses other than wages are covered by a PWA loan to the Coast and Geodetic Survey; wages to be paid by the CWA. American Engineering Council, by request, is assisting in acquainting the various engineering groups of the large amount of engineering employment which is being made available.

Missouri Public Works Delayed by Lack of Enabling Legislation

Public works amounting to $29,400,000 are being delayed in Missouri because of the failure of the Missouri general assembly, now in special session, to pass legislation to enable municipalities to apply to the federal Public Works Administration for loans, according to a report to the PWA by Hugh Miller, state engineer, PWA.

Among the projects tied up are $20,000,000 in buildings and improvements to state institutions, a $6,500,000 sewer system in St. Louis county, a $875,000 mineral water development at Excelsior Springs, and about $2,000,000 worth of electric, gas, sewer and water projects.

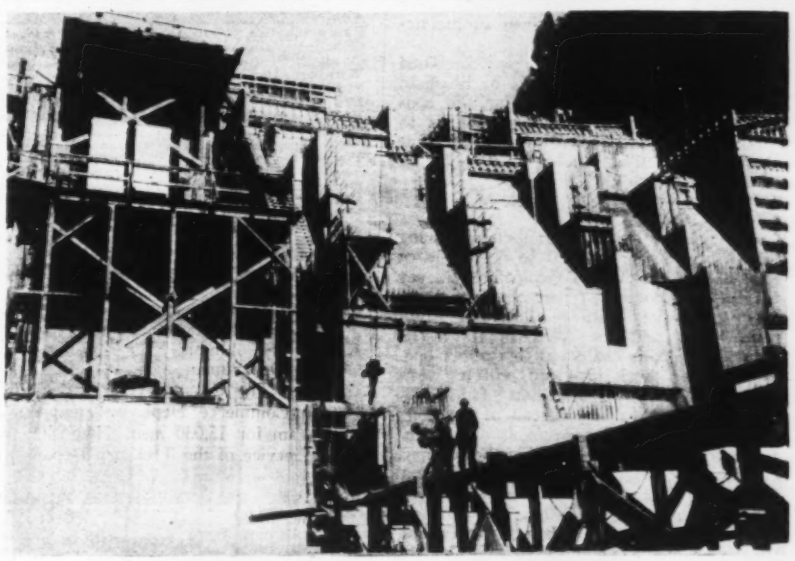
Thaddeus Merriman, Engineer of New York Water Board, Retires

Thaddeus Merriman, chief engineer of the Board of Water Supply of the City of New York, retired from active service with the board on Nov. 30. In seeking retirement Mr. Merriman stated that as no new development work is in prospect and as the work now under way is well in hand, it can be carried forward to successful and satisfactory completion by the department engineers Spear, Clark and Guttridge.

Mr. Merriman has been chief engineer of the Board of Water Supply since the retirement of the late J. Waldo Smith in 1922. His service with the board began in 1905 as an assistant engineer on the preparation of general plans and estimates for the Catskill water supply system and on general studies and surveys in the reservoir department. He was appointed assistant to the chief engineer in 1907.

Mr. Merriman was born in New Haven, Conn., in 1876, and graduated from Lehigh University in the class of 1897. Previous to graduation he had spent some time on municipal work and railway surveys, and following his graduation he was with the Nicaragua Canal Commission and with the Isthmian Canal Commission for about three years. Returning to the United States in 1900, he joined the staff of the New York Continental Jewell Filtration Co. on designs for the filtration plant at Little Falls, N. J., serving there for about a year, and then was an inspector on railway equipment being exported to Ecuador.

From 1902 to 1905 he was with the Jersey City Water Supply Co., first as assistant engineer on construction of the Boonton dam and then as division engineer in charge of that work and on general hydraulic and construction work for the East Jersey, Passaic and Acquackanonk Water Co., in which work he served under J. Waldo Smith.



BOULDER DAM RISES ABOVE THE CANYON FLOOR

The accompanying photograph indicates the progress being made on Boulder Dam more clearly than do the figures as to the number of yards of concrete being placed each month. It shows a section of the downstream face during the installation of the cooling system header pipes. Lead lines from the refrigeration plant and the evaporating tower are shown in the lower left hand corner of the picture.

Pending Applications for PWA Loans Exceed $3 Billion

PENDING applications for loans and grants for non-federal projects as of Nov. 26 call for an expenditure of $3,160,000,000 according to an announcement made by the Public Works Administration. On that date only $450,000,000 of the public works fund was unallocated.

The figures show that there were pending at the time the PWA made its survey 4,661 non-federal applications regarded as worthy of consideration. Of this number 1,821, calling for an outlay of $1,618,600,000, were pending in the PWA offices in Washington. State offices had in hand 2,840 applications for $1,541,800,000. As at Nov. 26 the breakdown of the original fund of $3,300,000,000 was as follows: $400,000,000 for roads, $238,000,000 for naval construction, $1,332,000,000 for federal projects, $480,000,000 for non-federal projects, $400,000,000 for the Civil Works Administration and $450,000,000 not allocated.

Loan contracts sent out

The PWA has sent out bond purchase contracts and grant agreements covering allotments of funds to 202 non-federal projects since Nov. 1, it was announced as of Nov. 23. Two hundred were sent out prior to Nov. 1, making a total of 402 non-federal contract allotments with a total value of $146,000,000. Of this total five large projects account for $114,390,000, with 13 other projects involving between one and five million dollars accounting for another $24,101,203, and the remainder is divided among 384 projects of less than $1,000,000 size.

Non-federal projects

Applications for loans and grants for non-federal projects approved during the week ending Nov. 25 total 92 and involve $72,391,430. Details are given in the accompanying table.

Notable among them are two combined loans and grants to the cities of Sheffield and Tuscumbia in Alabama for the construction of electric transmission lines to connect the two cities with the power plant of the Tennessee Valley Authority at Muscle Shoals.

Federal work

Among the allotments announced during the past week for federal work is one of $280,000 to the U. S. Geological Survey for the construction, repair and equipment of river gaging stations along the Colorado River and the Mississippi and its tributaries. It is estimated that about one-third of the work provided will be work for engineers. An allocation of $127,300 has been made to the Bureau of Fisheries for a survey and improvement of streams and lakes in various sections of the country, chiefly in national parks and national forests. $9,300 was allotted to the bureau for the preparation of designs for fish protection at the Bonneville dam on the Columbia River and $15,000 for a study of the effect of stream pollution upon fish life in the upper Mississippi River. A sum of $253,500 was allotted to the Bureau of Prisons for repair and alterations to the prisons on Alcatraz Island in California. Other allocations to federal departments total nearly $700,000, of which $200,000 was for the replacement of obsolete elevators in the Interior Department building in Washington.

Labor board for public works

Announcement has been made of the appointment of a board of labor review of the Federal Emergency Administration of Public Works, to hear all issues arising under the operation of all contracts financed from public works funds, its decision to be binding upon all parties. The board, which will be under the direction of United States Senator Robert W. Wagner, of New York, chairman of the National Labor Board, is composed of three members. Professor Lindsay Rogers, of New York, who will represent the Public Works Administration, has been designated chairman. The other members are James Wilson, of Cincinnati, representing labor, and Ernest John Russell, architect, of St. Louis, representing contractors.

DETAILS OF PWA LOANS AND GRANTS FOR NON-FEDERAL WORK

Locality	Loan or Grant	Type	Man-Months Work Provided	Amount
Medicine Park, Okla.	L.	Toll Road	1,785	$100,000
Miami, Fla.	L. & G.	Water System	3,000	560,000
Albert Lea, Minn. (amended)	G.	Street Repairs	180	32,000
Glen Rock, N. J.	L. & G.	Sewerage	150	22,000
Weston, Idaho	L. & G.	Water Mains	30	14,000
Lake City, Fla.	L. & G.	Waterworks	180	69,000
Bozeman, Mont.	L. & G.	Buildings	430	218,000
Geneva, N. Y.	L. & G.	Sewer	1,920	305,000
Hinsdale, Ill.	L. & G.	Force Main	90	21,000
Deer Lodge Co., Mont.	L. & G.	Buildings	158	50,000
Newton, Mass.	L. & G.	School Building	512	148,500
Bloomington, Ind.	L. & G.	Sewers	2,600	495,000
North St. Paul, Minn.	G.	School Building	180	17,000
Butte, Mont.	L. & G.	H. S. Building	2,300	800,000
Corbin, Ky.	L. & G.	Waterworks	280	70,000
State of Mass., Foxborough	L. & G.	Buildings	700	217,000
State of Mass., Belchertown	L. & G.	Buildings	240	98,000
Baker, Ore.	L. & G.	Sewage	550	105,000
Cameron, Texas	L. & G.	Sewers	375	37,000
State of Mass., Foxborough	L. & G.	Building	120	77,000
St. Joseph, La.	L. & G.	Streets	12	5,200
State of Mass., Monson	L. & G.	Steam Lines	360	100,000
Bridgeport, Conn.	G.	Sewers	1,200	33,600
Memphis, Tenn.	L. & G.	Sewer System	2,088	280,000
State of Mass., Norfolk	L. & G.	Building	560	146,000
State of Mass., Norfolk	L. & G.	Boiler Equip.	105	35,000
Minneapolis, Minn.	G.	Building	1,400	84,000
Pueblo, Colo.	G.	Water System	280	16,000
Lawler, Iowa	G.	Light and Power	30	1,400
State of Mass., Canton	L. & G.	Buildings	450	115,000
Burlington, Vt.	G.	Water System	60	3,200
Alameda, Calif.	G.	Bridge	3,600	190,000
Janesville, Wis.	G.	Sewage	450	45,000
Caldwell, Texas	G.	Roads	70	5,000
Springer, N. M.	L. & G.	Water System	150	45,000
Honolulu, Hawaii	G.	General Impr.	2,750	162,000
Sheffield, Ala.	L. & G.	Power	500	230,000
Tuscambia, Ala.	L. & G.	Power	300	130,000
Durham, N. C. (amended)	L. & G.	Sewers	3,300	50,000
				(increase)
Petersburg, N. D.	L. & G.	Village Hall	84	18,050
Tacoma, Wash.	L. & G.	Water	3,450	1,000,000
Cottage City, Md.	L. & G.	Streets	160	72,000
Essex County, Vt.	G.	Highway	200	9,000
Nashua, N. H. (amended)	G.	Streets	1,650	51,000
Greenfield, Ind.	L. & G.	Sewers	270	48,000
Worcester, Mass.	G.	Sewers	1,050	66,000
Auburn, Ill.	L. & G.	Water	2,100	299,000
Pawnee, Ill.	L. & G.	Waterworks	400	74,000
Chatham, Ill.	L. & G.	Waterworks	350	63,000
Council Bluffs, Iowa	G.	Water	1,000	29,000
Windsor, Ill.	L. & G.	Waterworks	360	65,000
Shippensburg, Pa.	L. & G.	School	540	75,000
Hamilton, Ohio	L. & G.	Reservoir	2,400	850,000
Walhalla, S. C.	L. & G.	Dam	126	32,000
Whitefield, N. H.	L. & G.	School	408	114,500
New Cumberland, W. Va.	L. & G.	Sewer	180	28,000
Teaneck, N. J.	L. & G.	School	640	215,000
Stonington, Ill.	L. & G.	Water	120	30,000
Hudson County, N. J.	L. & G.	Hospital Bldgs.	8,592	2,996,000
Newton, Mass.	L. & G.	School	1,200	248,400
Houston, Texas	L. & G.	Waterworks	9,000	2,502,000
Newton, Mass.	L. & G.	School	210	60,700
Ligonier, Ind.	L. & G.	Waterworks	135	27,000
Muskogee, Okla.	L. & G.	Reservoir	805	165,000
Appleton, Minn.	L. & G.	Sewage plant	175	44,000
Perth Amboy, N. J.	L. & G.	Sewage plant	5,600	859,000
Whatcom County, Wash.	G.	Roads	75	3,000
Roopville, Ga.	L. & G.	School	30	12,000
Gregory County, S. D.	G.	Jail	237	14,000
Arlington, Minn.	G.	Schools	315	28,100
Maxeys, Ga.	G.	School	22	1,100
Carthage, Ill.	L. & G.	School	300	82,000
State of Mass., Boston	L. & G.	Hospital Impr.	150	45,000
Moweawua, Ill.	L. & G.	Water	38	9,000
Medical Lake, Wash.	G.	Hospital	550	31,800
Rochester, N. Y.	L. & G.	School	6,000	1,490,000
Ouray, Colo.	L. & G.	Water	75	18,000
St. Regis, Mont.	G.	School	160	12,000
Pullman, Wash.	G.	Drainage	20	800
Guthrie Center, Iowa	G.	Sewage	7	400
College Station, Texas	G.	Street Impr.	345	10,500
Weiser, Idaho	G.	Water	50	5,000
Atlantic, Iowa	G.	Water	94	8,100
Marshalltown, Iowa	G.	Sewer	50	2,500
Decorah, Iowa	G.	Water	120	6,000
Manly, Iowa	G.	Recreational Facilities	20	900
Sioux County, Iowa	G.	Roads and Bridge	450	20,000
Redwood Falls, Minn.	G.	Sewers	125	6,000
Holdrege, Neb.	G.	Sewage	40	3,000
Nashville, Tenn.	G.	Buildings	825	57,400
Salina, Kan.	G.	Pumping Station	120	6,000
Atlanta, Ga.	L. & G.	Police Station	1,150	346,000
		Total	86,018	$17,391,450

Contract Let for Steel Towers of Triborough Bridge, New York

The Triborough Bridge Authority, New York, has awarded the contract for the construction of the towers and anchorage cable bents of the Triborough Bridge connecting the boroughs of Manhattan, Bronx and Queens to the Taylor-Fichter Steel Construction Co. on a bid of $1,647,000 for the towers and $14,000 for the anchorage cable bents.

Other bids submitted were: McClintic-Marshall Co., $1,759,000 and $46,700; American Bridge Co., $1,937,739, and $43,934, Phoenix Bridge Co., $1,979,400 and $49,200.

State of Illinois Acts To Facilitate PWA Borrowing

To permit municipalities in the state to comply with the requirements set up for loans from the Public Works Administration, the General Assembly of the state of Illinois recently passed a number of emergency bills that now have become law.

The act setting up the Chicago Sanitary District has been amended to authorize the trustees to convey or lease property to the federal government, and somewhat similar provisions are made in laws affecting municipalities, park districts, boards of education and drainage districts.

Under the provisions of acts affecting borrowing beyond the present limit of 5 per cent of assessed valuation, municipalities and municipal districts can convey property to the federal government and lease it back at an annual rental. The annual rental is considered current expenses of the year and not indebtedness.

Virginia Water and Sewage Association Votes to Affiliate with A.W.W.A.

BY a unanimous vote the Virginia Water and Sewage Works Association, at its annual meeting at Newport News on November 16-18, voted to affiliate with the American Water Works Association as the Virginia Section. The newly elected officers were instructed to file an application for such affiliation with the board of directors of the A.W.W.A. to be considered at the forthcoming January meeting.

The recent creation by the federal government of the Civil Works Administration featured the discussions at the technical meetings of the association. Taking part in these discussions were J. A. Anderson, state public works engineer for Virginia, and several members of the state advisory board. Greatest interest was displayed in the proper line of demarcation to be observed between public-works projects to be undertaken by the CWA and those under the domain of the PWA.

Progress on public works

In reporting on the progress of the public-works program in Virginia, Col. Anderson stated that applications for loans and grants totalling more than $15,000,000 had been forwarded to Washington by his organization, but that a small proportion of this amount had reached the contract stage. Many of the larger projects are being delayed by the popular referendum elections still to be held.

An appraisal of the results of municipal ownership in the case of the Newport News water supply system, which was purchased by the city in 1926, was made by J. C. Biggins, city manager. Since the date of purchase, extensions have been made totalling $440,000, bonds have been retired amounting to $216,000, and taxes of $186,000 have been paid, all out of current revenue. Mr. Biggins termed municipal ownership in Newport News completely successful.

Taste and odor control

The experiences of Norfolk, Va., in combating objectionable tastes in the water supply were recounted by R. W. Fitzgerald, chief chemist. The condition was caused by decaying organic matter and the growth of algae in the impounded reservoir. For four years water had been stored in this reservoir before its use was begun. Copper sulphate, prechlorination and aeration were all used at first, in 1926, but with only partial success. Research on the use of chloramine sterilization indicated that this treatment would not affect the algae taste, but would prevent chlorinous tastes. Success in taste correction was attained through a combination of prechlorination and activated-carbon treatment.

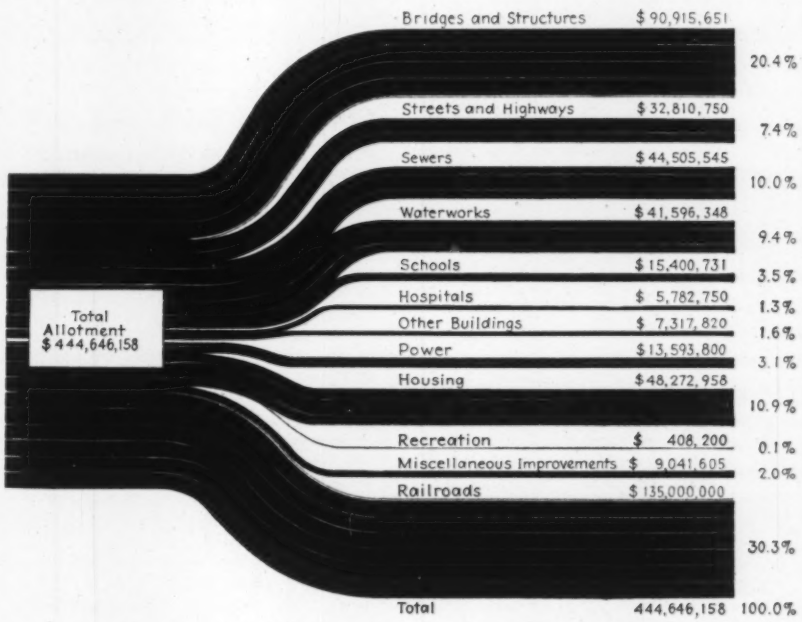
An unusual sprinkler installation was described by H. E. Silcox, of the C. & O. Ry. At Newport News, which is an important coal exporting point, the C. & O. Ry. has provided facilities for sprinkling bituminous coal for the purpose of reducing dust as the coal is unloaded from railroad cars into cargo vessels. Unloading takes place at two coal piers, one of which is of the elevated and the other of the low-level type. The sprinkling is of great economic importance as it reduces materially the cost of handling. Water to the extent of 1½ to 2 per cent of the weight of the coal is used for sprinkling. Trouble was experienced at first from uneven water pressure, resulting in lack of uniformity in the sprinkling rate, but this condition was relieved by the erection of a 100,000-gal. elevated tank.

The recent developments in water softening were discussed by C. P. Hoover, of Columbus, Ohio. Mr. Hoover dwelt at some length on the studies made recently to evaluate the cost of soap waste in hard-water cities.

Sewage-treatment developments

Wellington Donaldson, of New York City, presented to the meeting the latest developments in sewage-treatment processes. The principal treatment methods were described, together with the degree of purification of which they are capable. It was shown that the chemical methods now receiving attention, with one exception, give treatment higher than plain settling but lower than the activated-sludge process. The exception is the Guggenheim process, which includes the use of Zeolite to remove ammonia from the settling-tank effluent. Mechanical filtration of sludge has proved quite successful in practice, and incineration of dewatered sludge is growing rapidly in popularity.

At the business meeting of the association, B. S. Parrish, of Martinsville, was elected president for the coming year. E. F. Dugger, of Newport News, was selected to be the Virginia section's member of the A.W.W.A. board of directors.


Total Allotment $444,646,158
Bridges and Structures $ 90,915,651 20.4%
Streets and Highways $ 32,810,750 7.4%
Sewers $ 44,505,545 10.0%
Waterworks $ 41,596,348 9.4%
Schools $ 15,400,731 3.5%
Hospitals $ 5,782,750 1.3%
Other Buildings $ 7,317,820 1.6%
Power $ 13,593,800 3.1%
Housing $ 48,272,958 10.9%
Recreation $ 408,200 0.1%
Miscellaneous Improvements $ 9,041,605 2.0%
Railroads $ 135,000,000 30.3%
Total 444,646,158 100.0%

DISTRIBUTION OF NON-FEDERAL PUBLIC WORKS ALLOTMENTS

The accompanying chart shows graphically the distribution of public works allotments for none-federal projects up to Nov. 17. The large item for bridges and structures is made up chiefly of $44,200,000 for the Triborough Bridge and $37,500,000 for the Midtown Hudson Tunnel at New York.

The large item for railroads is made up of $84,000,000 for the completion of the Pennsylvania Railroad's electrification between New York and Washington and $51,000,000 set aside for loans to railroads for the purchase of rails, fastenings and other equipment.

Long Beach Not To Withdraw From California Water District

Voters of Long Beach, Calif., at a special election held Nov. 21, refused to sanction the proposed withdrawal of the city from the Metropolitan Water District of Southern California. The vote was 14,989 against withdrawal and 11,382 favoring withdrawal. Seven bond issue proposals were defeated at the same election. The proposals, calling for a total of $1,061,500, included construction of a library, city hall repairs, construction of a fire station, Belmont Pier repairs, storm drain construction, a municipal comfort station and airport improvements.

Contract Let For Nearly Half of Army Post Construction

By mid-November contracts had been let for about one-half of the $55,000,000 of army post construction and reconditioning provided for by PWA allotment to the War Department. At that time, the Quartermaster Corps of the Army was advertising for bids on $1,000,000 per day, and it expected the last of the contracts to be let by Jan. 1. Much of the work will run through the greater part of the coming year.

The work consists in the main of revamping and in some cases expanding old army posts and substituting permanent for temporary construction at new posts. All are to be modernized on an enduring basis.

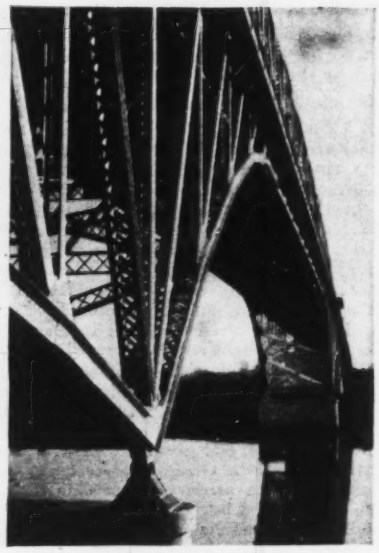
Most of the work relates to living quarters and appurtances for troops. This consists of the overhauling, in some instances enlarging, and re-equipping old barracks and officers' quarters, the erecting of new structures of like kind, the building of roads, new installations for heating, wiring for telephones, the erection of post chapels, theatres, etc., and in some cases warehouses, hangars, garages and hospitals.

Engineering Board in Illinois to Approve CWA Projects

An advisory committee of civil engineers, headed by Prof. C. W. Huntington, University of Illinois, and serving without pay, has set up a full time paid engineering division of engineers to pass on civil works projects being undertaken in Illinois by the Civil Works Administration. Other members of the personnel board are: Albert Reichmann, assistant chief engineer, American Bridge Co.; A. J Hammond, president, Am. Soc. C.E.; C. C. Whittier, president, Chicago Engineers Club; Magnus Gunderson, chief structural engineer, Graham, Anderson, Probst & White; D. J. Brumley, president, Western Society of Engineers; C. B. Burdick, consulting engineer; and C. M. McChesney, vice-president, Acme Steel Co.

About $20,000,000 is assigned to Illinois to absorb 187,000 unemployed, nearly half of which number are in Cook County. Regional engineers and project engineers will be appointed throughout the state to supervise the projects passed upon by the division.

The members of the engineering division CWA which will pass on the engineering phases of projects and maintain inspection and supervision are Frank D. Chase, chief engineer, H. E. Kellogg, P. E. Green and A. R. Lord, who will be executive secretary. All of these engineers are from Chicago. Two from downstate are yet to be appointed.



LOUISIANA DEDICATES NEW RED RIVER BRIDGE

A new bridge at Shreveport, La., dedicated Oct. 21, 1933, provides a needed connection with Bossier City on the opposite bank of the Red River. The structure, which carries U. S. Highways 71 and 80, was built by the Louisiana state highway department. It consists of a 520 ft. main cantilever span, two 182-ft. anchor spans and six 102 ft. deck truss spans. All trusses are of "K" type. In the approaches there are 35 reinforced concrete deck-girder spans ranging in length from 24 to 50 ft. and one 81-ft. steel girder span. The main river piers were sunk under air. Construction of the bridge started Aug. 14, 1931, but work was delayed for a period of six months from April 20, 1932, until Oct. 20, 1932, because of financing difficulties. These finally were overcome by A. P. Tugwell, chairman of the highway commission, and the bridge was completed Oct. 10, 1933. List & Weatherly Construction Co., Kansas City, Mo., had the general contract, and the Virginia Bridge Co., Memphis, furnished and fabricated the 2,500 tons of structural steel involved. For the state highway department N. E. Lant is bridge engineer and E. L. Erickson assistant bridge engineer. S. C. Waller was resident engineer.

Large Housing Project Advanced

The Boulevard Gardens Housing Corp., New York, has announced that it has reached an agreement with the Public Works Administration over the details of the proposed PWA loan to the corporation to finance the construction of low-rental houses in Woodside in the borough of Queens. The company is a limited-dividend corporation. Several weeks ago the PWA gave tentative approval to a loan of $3,210,000 to the corporation to construct ten six-story semi-fireproof elevator apartments providing 1,632 residential units totalling 5,644 rooms to rent at about $11 per month per room. At that time it was stated that the loan was to be made to the Dick-Meyer Corp., a company organized under the New York State housing law.

Engineer Registration Board Appointed in Ohio

To administer the recently-enacted registration law for engineers and surveyors in the state of Ohio, the Governor has appointed the following as members of the board of registration for engineers and surveyors: Perry Ford, Ottawa; C. C. Lattimer, Columbus; J. O. McWilliams, Cleveland; H. G. Sours, Akron; and Walter W. Graff, Lancaster. The members are to serve from one to five years in the order of naming. The board will establish its headquarters at Columbus.

Oklahoma Highway Program Nearly All Under Contract

Highway improvement and construction work in the federal-state emergency road building program has passed the $2,500,000 mark in projects actually in progress in Oklahoma with work orders issued by the state highway commission, according to L. B. Selman, vice chairman. The commission so far has awarded 66 contracts, on 59 of which work orders already have been issued. Included in these orders are projects representing a total contract price of $2,634,000, with $280,765 in projects remaining on which work orders have not yet been issued.

Baltimore Approves Contract For PWA Loan and Grant

The Board of Estimates, Baltimore, has passed resolutions ratifying contracts with the Federal Government for the PWA covering the municipal program, which calls for the expenditure of $1,730,000 on schools, streets and highways, sewer extensions, a pumping station, and other projects, all of which are expected to be under way in the near future.

Government Rejects Bids on New York Post Office Annex

All bids on the superstructure for the annex to the main post office at New York were rejected by the Treasury Department on Nov. 27. While no explanation of the action was made it is believed to have been done to escape the issue of compliance with the NRA.

Foundations for the building which is to be built over the tracks of the Pennsylvania Railroad terminal on 9th Ave. between 31st and 33rd Sts., were completed some time ago. Bids on the superstructure were first opened last February and supplemental bids were opened on Oct. 2. The George F. Driscoll Co., Brooklyn was the low bidder on the latter call. Recently (*ENR*, Nov. 2, p. 540) the government proposed to award the contract to the second-low bidder on the ground that the Driscoll company had not signed the President's Reemployment Agreement when it bid.

Subsequent to bidding the company did sign the agreement and, more recently (*ENR*, Nov. 16, p. 607) the Controller General held that the fact that the company had not signed at the time it bid had no material bearing on the question of award of the contract.

Brief News

CONSTRUCTION OF a $700,000 water filtration plant at Hammond, Ind., has been approved.

PREQUALIFICATION OF CONTRACTS is under consideration in the state of Arkansas. Recently the Arkansas General Contractors Association met at Little Rock and appointed committees to develop the standards for the several divisions of general construction work.

A COMPETITION FOR THE DESIGN of a hangar for airships is being held by the section for scientific research, Dirigeablestroy, (Civil Aerofleet) Moscow, Russia. The prizes range from a first prize of 10,000 rubles to three smaller prizes of 1,000 rubles each, but all payments will be made in U.S.S.R. currency. Entries have to be in by Jan. 1, 1934.

PRIVATELY OPERATED UTILITIES, water, gas, telephone, telegraph, electric power companies and toll bridge companies, have been asked by the department of public works of the state of Washington to file their budgets with the department under a law recently passed by the state legislature. The budget must show amounts needed for the year 1932 for construction, maintenance and operation and among other things must show wages paid and types of service performed.

FEW JOBS ARE AVAILABLE at the present time at the site of the Fort Peck Dam in Montana, according to an announcement made recently by the Secretary of War. Clearing of the dam site has been started but local labor is available in sufficient number to meet demands for the work immediately in prospect, and additional employees will be secured as required through the National Reemployment Service. Public announcement will be made when more labor is needed.

STATE SUPREME COURT APPROVAL of an agreement between Tulsa city officials and taxpayers has cleared the way for construction of three major bridge and street improvement projects in the West Tulsa sector of Tulsa, Okla. The project will leave unused about $100,000 out of the $405,000 bond issue, and whether this excess must be spent in improvement or may be transferred to a sinking fund for the retirement of these bonds, remains to be decided.

AN AGREEMENT on final details in connection with the $400,000 seawall and levee project to protect the business section of Hickman, Ky., has been reached between the United States army engineers, the Nashville, Chattanooga & St. Louis R.R., and the city and it is expected that the contract for construction of the seawall will be let soon. The contract was to have been let Oct. 25, but objection of the railroad to the plans caused a delay. Now that the city council has voted to meet the railroad's conditions, the project may be expected to proceed rapidly.

AN APPEAL FROM THE ADVERSE FINDINGS of the army engineers in relation to the improvement of the Beaver, Shenango and Mahoning rivers in Pennsylvania and Ohio has been filed with the United States Board of Engineers for Rivers and Harbors by the Chamber of Commerce of Youngstown, Ohio. The army engineers reported unfavorably and found the cost of developing the rivers to serve as a waterway for the Youngstown district not justified by the possible economies; also they questioned the adequacy of the available water supply for canal operation.

CONTRACTS FOR 5.4 MILES OF brick paving extending north and south of the city of Boynton, Okla., have been let by the state highway department. It is stated that this has been done primarily to provide employment in the brick plant at Boynton. The practice of employing brick as a paving material, though uncommon in Oklahoma, is normal procedure in brick producing states like Ohio, where it is necessary to lay a certain amount each year.

REVALUATION OF THE PROPERTIES of the East St. Louis and Interurban Water Company, East St. Louis, Ill., may be carried out by the Illinois Commerce Commission in order to fix reasonable rates for its services based on such a valuation, according to a ruling of the Federal Court of the western district of Illinois. Seven years ago the company obtained an injunction from the Federal Court to prevent the State Commission from taking similar action.

A NEW FIRST-ORDER TRIANGULATION survey in the vicinity of New York has been begun by the U. S. Coast and Geodetic Survey by a party under charge of Lieut. John Bowie, Jr. The party has established its headquarters in Newark and will carry its first-order control station in New Rochelle and on the east end of Long Island, across upper New York City to the New Jersey side near Englewood, then south through Perth Amboy. The service stations are on the roofs of the higher buildings. Observations are being made after dark on signal lamps set up at the various stations.

CONTINUED LOW WATER in the harbor at Montreal with its serious effect upon shipping has resulted in urgent requests being made upon the Department of Marine for definite action to correct this situation. A proposal has been made to the department for the creation of a series of low underwater dams along the river between Montreal and the wide section below Montreal known as Lake St. Peter, also for the construction of a dam near the outlet of Lake St. Peter to restrict the discharge of the river at that point.

UNEMPLOYED RESIDENTS IN IMPERIAL VALLEY will be given preference over the jobless of other sections of Southern California in the recruiting of approximately 2,000 men to work on the All-American canal project beginning the first of next year, according to J. H. Fallin, assistant director of the Los Angeles, Calif., office of the Federal Department of Labor. The announcement was made at the suggestion of the El Centro Chamber of Commerce. Mr. Fallin said, to counteract rumors that jobs will be available for men from all of California.

SOCIETY CALENDAR

AMERICAN ROAD BUILDERS ASSOCIATION, annual convention, Chicago, Jan. 22-26, 1934.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual meeting, New York, Jan. 17-20, 1934.

AMERICAN TOLL BRIDGE ASSOCIATION will hold its annual convention at Cincinnati, Ohio, Jan. 26-27.

ENGINEERING INSTITUTE OF CANADA, 48th annual general meeting, Montreal, Que., Feb. 8-9, 1934.

HIGHWAY RESEARCH BOARD, National Research Council, Washington, D. C., Dec. 7-8.

CONNECTICUT ROAD BUILDERS ASSOCIATION, at a general meeting during the past week, voted to affiliate with the American Road Builders Association.

INDIANA SECTION, American Society of Civil Engineers, at its mid-November meeting held in Indianapolis, elected H. S. Morse as president, and Louis W. Bruck as vice-president. W. A. Knapp is secretary-treasurer. John N. Dyer, member of the examining board for the Public Works Administration, spoke on the pollution of streams in northern Indiana. Other speakers were A. H. Hinkle, state engineer, PWA for Indiana, and M. E. Keefe, chief engineer of the State highway commission.

NEW YORK SECTION, American Welding Society at its meeting on November 22 was treated to a broad presentation of the subject of aluminum welding. Speakers were H. V. Churchill, D. I. Bohn and G. O. Hoglund, all of the Aluminum Company of America. Welding procedures for the common alloys of aluminum, using both the gas and arc processes, have been successfully established for a long time, as witness cooking utensils and airplane fuselages. Heat-treated alloys, which comprise structural aluminum, present a welding problem for the future. Fusion processes anneal the metal near the weld and destroy its strength. Resistance or pressure welding holds the greatest promise for successfully welding structural aluminum, but its use too presents many difficult and unsolved problems. In addition to discussing the technical phases of the subject, the speakers also emphasized welding costs.

Personal

CHARLES ASH, former division engineer of the Ohio highway department, has been appointed an engineering investigator for the Public Works Administration in the state of Ohio.

C. E. MYERS, consulting engineer, Philadelphia, Pa., has been appointed chief consulting engineer for the Civil Works Administration in Pennsylvania with headquarters at Harrisburg, Pa.

A. R. MCGINNESS, formerly with the U. S. Bureau of Reclamation and more recently structural engineer with the building department of the city of Long Beach, Calif., is now associate bridge designing engineer with the bridge division of the California state highway department at Sacramento, Calif.

GEORGE B. HERINGTON, who has been executive secretary and manager of the Portland chapter, A.G.C., for eight years, has resigned, effective Dec. 1, to enter private practice in construction management and adjustment of construction contracts. Mr. Herington will continue to maintain his office in Portland, Ore.

JULIAN C. SMITH has been elected president of the Shawinigan Water and Power Co., succeeding J. E. Aldred of Boston. Mr. Smith joined the company as an engineer at the time of the construction of its first power house, and has been serving in recent years as vice-president and managing director.

LEE H. HUNTLEY, of New York City, has been appointed construction superintendent for the General Joe Wheeler Dam (Dam No. 3) on the Tennessee River by the Tennessee Valley Authority. Mr. Huntley is a graduate of the University of

Wisconsin, and has specialized in the development of hydro-electric projects, both in the United States and in South America.

R. B. CHITTENDEN, who was recently employed in the construction division of the West Virginia Pulp & Paper Co., has been appointed general foreman on the housing project in connection with Norris Dam by the Tennessee Valley Authority.

J. H. DOWLING was recently appointed chief engineer of the Florida state road department, succeeding B. M. Duncan, who was appointed consulting engineer. Mr. Dowling has been division engineer of plans and surveys for the road department for several months.

Obituary

JAMES A. KELLY, assistant city engineer, Cohoes, N. Y., died there on Nov. 16, age 60 years.

DANIEL W. SEITZ, former deputy engineer of the highway department of the state of Ohio, died at Ottawa, Ohio, recently at the age of 83 years.

J. H. JOHNSON, a civil engineer of Salt Lake City, died there on Nov. 16, age 47 years. Mr. Johnson was a native of Sweden. He came to this country after exploration work in Africa.

HARRY MYERS, former engineer of the city of Pittston, Pa., died at his home in Wilkes-Barre, Pa., on Nov. 23, age 58 years. Mr. Myers was a graduate of Cornell University and in recent years had been in private practice as a consulting engineer at Wilkes-Barre.

LEICESTER DURHAM, assistant engineer, Board of Estimate and Apportionment, New York, died at Mount Kisco, N. Y., on Nov. 21. Mr. Durham was born in Chicago and graduated as a civil engineer from Columbia University in 1899. His first connection with rapid transit work at New York began in 1901 as an assistant engineer with the Rapid Transit Railroad Commission. From 1905 to 1914 he served with the Board of Water Supply and in 1914 joined the engineering staff of the Board of Estimate where he had served continuously except for a period during the world war when he served in the office of the Chief of Engineers in Washington and as an officer of the 116th Engineers in France.

SIR ALEXANDER HOUSTON, former director of water examination for the Metropolitan Water Board of London, England, died suddenly in London on Oct. 29. Sir Alexander had tendered his resignation on Oct. 6, as noted in our issue of Nov. 16, asking that it take effect at the end of the current year. His death closes a 28-year period of notable service to the city of London in which he made important contributions to progress in water purification throughout the world. Sir Alexander was born in India in 18[illegible] studied medicine at the University of Edinburgh and upon graduation was appointed bacteriologist to the Royal Commission on Sewage Disposal. He became connected with the Metropolitan Water Board as director of water examination in 1905.

PETER J. HURTGEN, director of public works, Kenosha, Wis., died suddenly Nov. 15, from a heart attack as he was driving to his office. He was born in Pewaukee, Wis., March 28, 1874, and following graduation from the Milwaukee School of Engineering for several years he was in the engineering department of the city of Milwaukee. Then for six years he was with the Milwaukee Electric Railway and Light Company. He then became city engineer of Burlington, Wis., and at the same time served as consultant for Delevan, Elkhorn, South Milwaukee, Lake Geneva and Marshfield, all nearby cities in Wisconsin. In 1916 he was made city engineer of Kenosha and director of public works in 1919. Active in local society work he was one of the founders of the West Shore Water Producers Association and a member of the American Water Works Association. For five years he had been treasurer of the International Association of Public Works Officials.

CONSTRUCTION STATISTICS OF THE WEEK

CONTRACTS REPORTED this week are short one day's lettings because of early closing of these pages to meet a holiday printing schedule. All awards totaled $24,115,000, almost all for public works, as private contracts were the lowest of the year, aggregating only $1,216,000. Federal awards were fairly heavy, mostly for army housing projects, with a contract for the new government office building at San Francisco, $2,513,000, swelling the total and ranking as the highest single award of the week. Highway lettings fell off from the level maintained for the previous two weeks, aggregating $6,465,000. Heaviest road lettings were reported from Texas, $931,000 and from California, $941,000, the latter being for approach roads to the Golden Gate bridge. Two large bridge contracts included steel towers and cable bents, Tri-Borough bridge, New York, $1,661,000 and substructures for the Sagamore and Bourne bridges over Cape Cod Canal, $1,338,000. The weekly average of contracts let in November is $29,530,000, second only to October awards for the year.

CONTRACTS
(Thousands of Dollars)

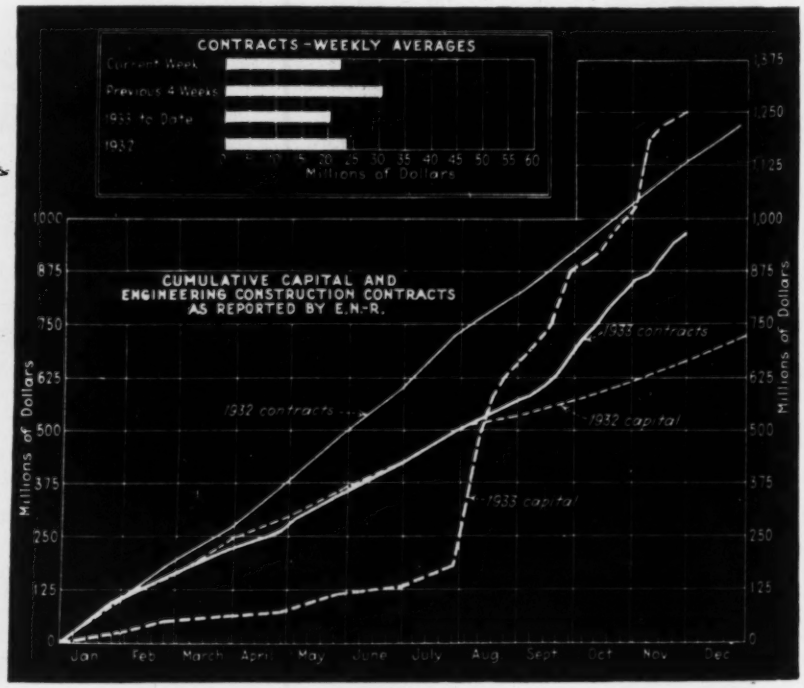
	Weekly Average Nov. 1932	Prev. 4 Weeks	Week Nov. 30, 1933
Federal Government	$6,269	$10,595	$10,391
State and municipal	15,479	14,670	12,508
Total public	$21,748	$25,265	$22,899
Total private	3,363	5,617	1,216
Week's total	$25,111	$30,882	$24,115

Cumulative to date:
1932....$1,136,621 1933.....$966,003

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

	Week Nov. 30, 1933	Cumulative 1933
State and municipal	$1,337	$272,200
PWA allotments, public	17,127	745,571
Corporate issues	113	50,385
PWA allotments, private	131	185,748
Total new capital	$18,708	$1,253,994
Cumulative, 1932		$663,000

Note: These figures include private bonds and stock sold for productive purposes; state and municipal bonds for construction; R.F.C. advances for self-liquidating loans; PWA loans and grants to states and municipalities, including the special highway funds; and PWA private loans.

INDEX NUMBERS

E.N.R.-Cost		E.N.R.-Volume	
November, 1933	190.14	October, 1933	162
October, 1933	187.74	September, 1933	122
November, 1932	158.20	October, 1932	137
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.35	1930 (Average)	260
1913 (Average)			100